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Progress of Work on the New Quebec Bridge during the First Erection Season

By H. P. Borden*

During the past season substantial progress has been made toward the erection of the new Quebec Bridge. In spite of the fact that the actual start on the work of erecting the main trusses of the anchor arm was not made until the middle of July, 1914, over 80% of the north anchor arm, amounting to some 15,000 tons, has been entirely erected, and for the most part riveted.

During the winter of 1913-1914, the traveler for this work was erected on the north shore, just clear of the abutment. On May 18, 1914, the traveler was completed and moved out over the approach span, which had been put in place the season before.

Two Sets of Falsework—From a position over the north anchor pier a start was then made on the erection of the steel falsework extending between this pier and the north main pier. The erection of two systems of falsework was required at this point: (1) An inside false-

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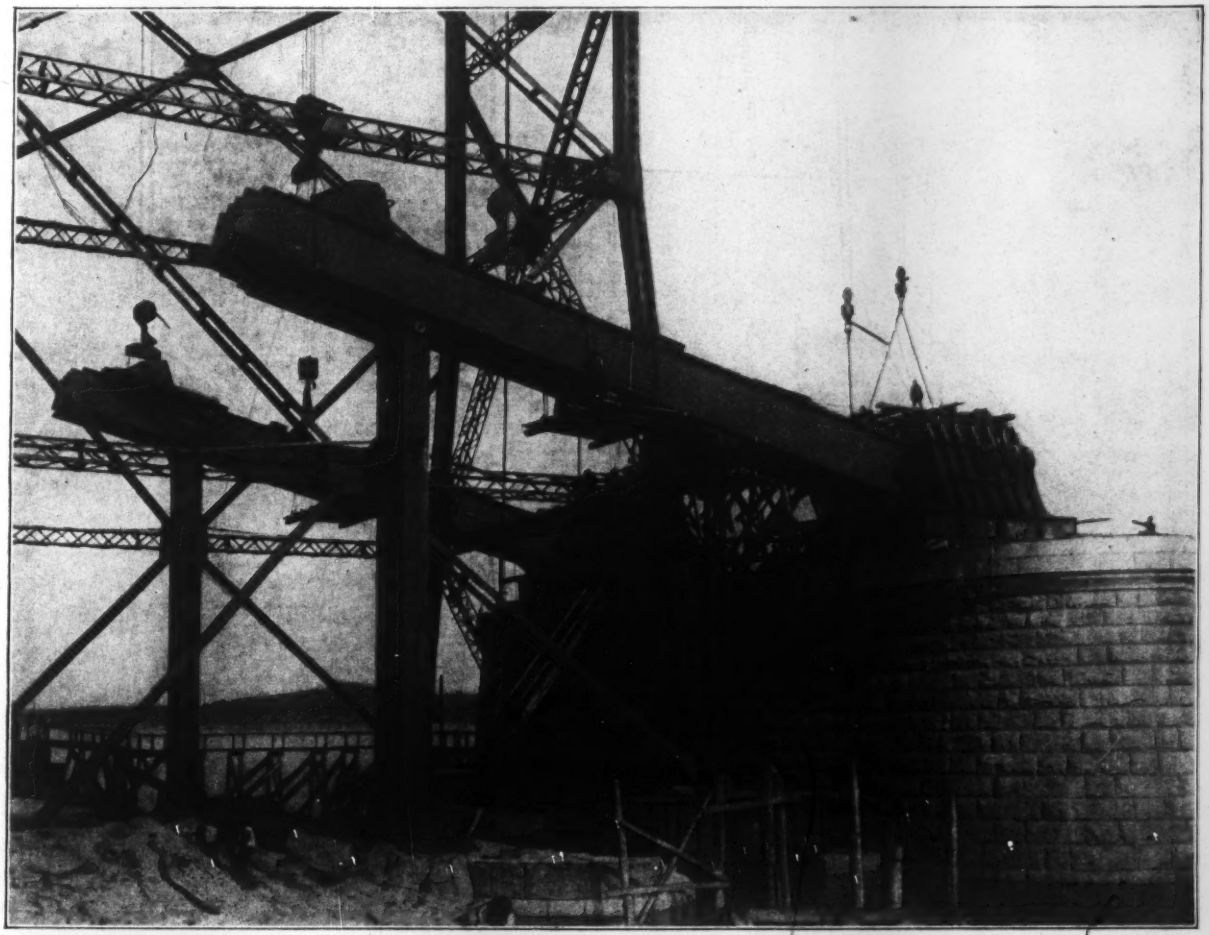
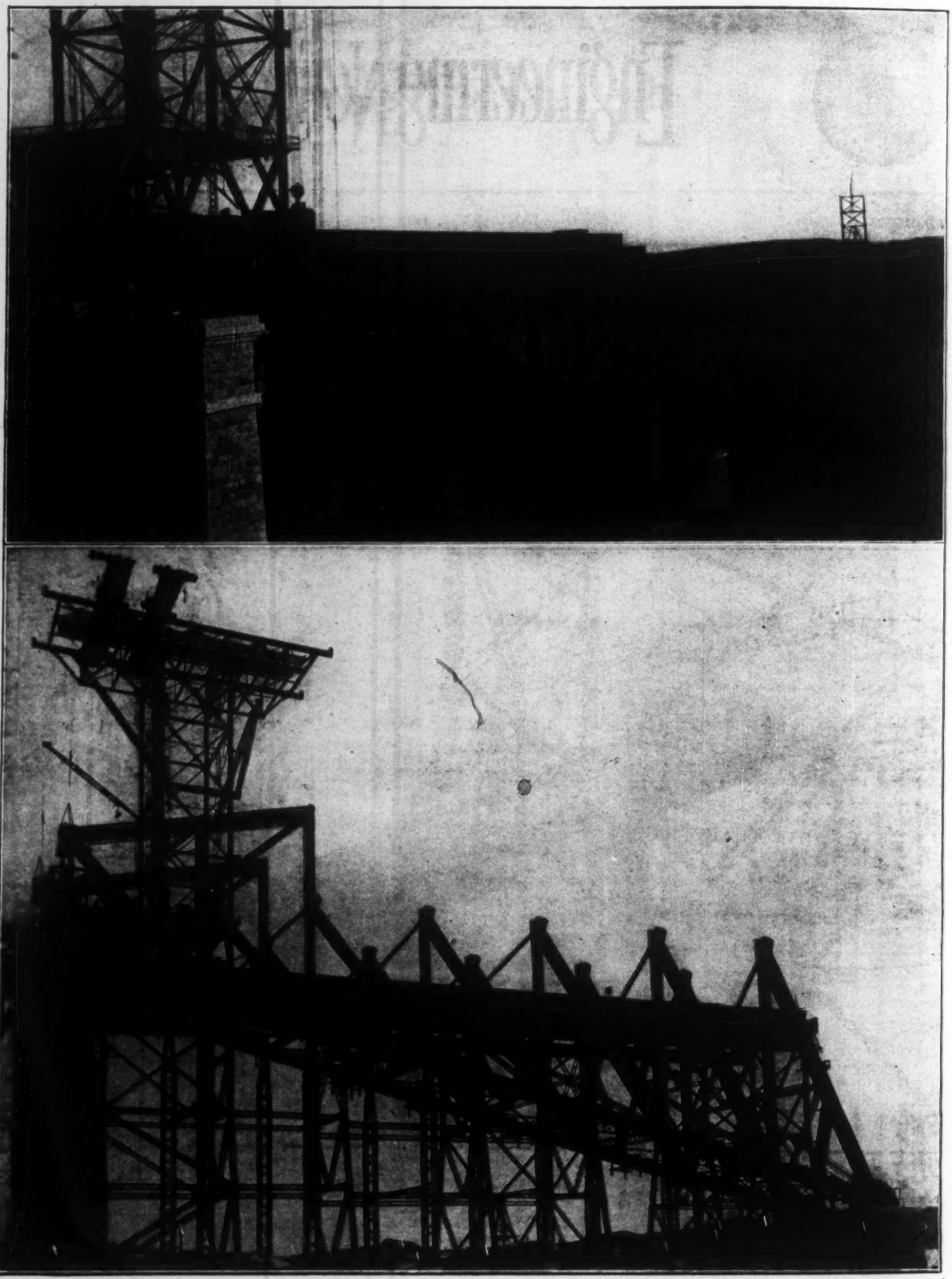


Fig. 1. Quebec Bridge Anchor Arm, Shoes and First Main Panel of Bottom Chord Set in Place, Aug. 4, 1914

(Note steel falsework for carrying the chord. Floor and traveler are carried by the independent inner falsework. Chord and shoe are connected by a 30-in. pin in a 45-in. bushing. The chord panel was erected in four pieces, spliced longitudinally and transversely; the transverse splice is just over the riveter staging.)



FIGS. 2 AND 3. QUEBEC BRIDGE ANCHOR ARM: BOTTOM CHORD COMPLETED (UPPER VIEW, SEPT. 3), AND LOWER HALF OF WEB SYSTEM ERECTED (LOWER VIEW, NOV. 17, 1914)

(The upper view shows girders and blocking supporting the chord between the panel-point falsework towers, for making the field splices.)

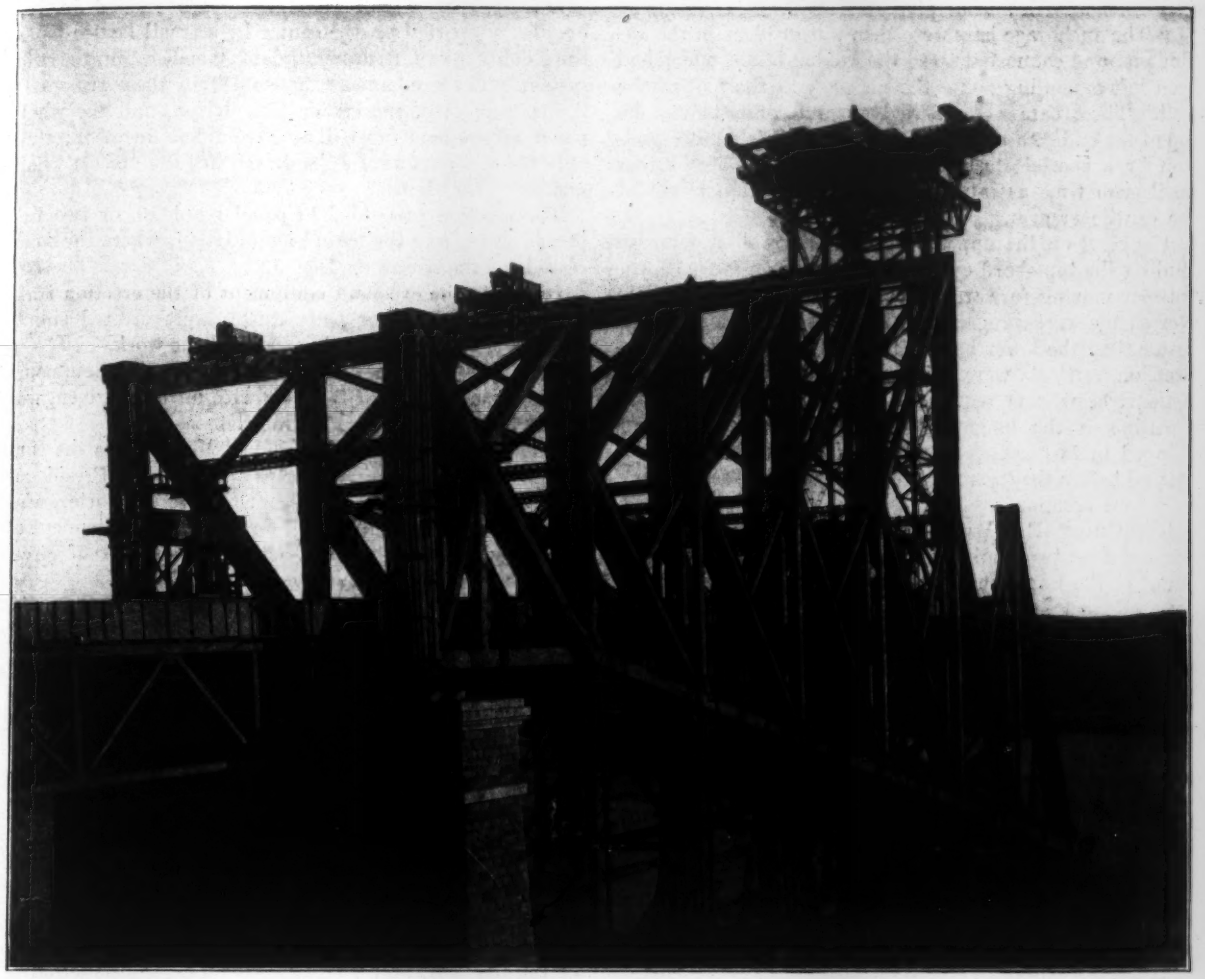


FIG. 4. THE QUEBEC BRIDGE AT THE CLOSE OF THE 1914 SEASON, DEC. 5

(In this view the double bank of eye-bars in the top chord, and their supporting trusses, are seen very clearly.)

work, which was required to support the *floor* of the bridge during erection and upon which the traveler and all erection equipment and plant were handled; (2) an outside falsework, entirely independent of the first, which supported the *trusses* of the anchor arm during erection.

The inside falsework consisted of seven bents, braced laterally and horizontally, the traveler moving ahead panel by panel as each bent was erected. These seven bents, covering a distance of 500 ft., were erected in practically two months, or at the rate of one bent a week.

On July 15, 1914, a start was made on the erection of the shoes on the north main pier. These shoes, weighing 400 tons each, had been completely erected in the shop before shipment and all holes reamed out either in place or to template, and all parts accurately matchmarked and stamped, so that the assembling at the site went ahead very quickly. By Aug. 1 they were entirely assembled and sufficient rivets driven to allow a start to be made on the erection of the bottom chords.

PLACING THE BOTTOM CHORDS—According to the scheme of erection, the bottom chords as a whole were erected on the outside staging from main to anchor pier before any of the web members were erected in place. The average main panel length being 86 ft., it was necessary to erect these lower chord members in four pieces for each panel, there being a transverse as well as a longitudinal field splice (both vertical). A full panel of bottom chord near the shoe (Fig. 1) weighs approximately 400 tons per truss. By Sept. 28 these chords were erected, connected up with the bottom lateral system, and the web splices riveted. (Fig. 2 shows the work a few weeks earlier.) The traveler moved back toward the anchor pier as the work progressed.

ERECTING THE WEB MEMBERS—When the traveler had finished the erection of the bottom chord, it was again moved forward to the main pier and the erection of the lower half of the web members (up to the point where the diagonals and the verticals intersect) was started. These diagonals, also, on account of their weight, had to be erected in four pieces between main panel points, having a vertical as well as a longitudinal field splice. As their ends are pin-connected, the erection of this portion of the web system proceeded rapidly. Each diagonal was accurately trued up and all the rivets in the vertical web splices were driven for the connection before it was connected to the vertical. No difficulty whatever was met with in the erection of these members.

The lower half of this web system was fully erected

back to the north anchor pier by Nov. 9, 1914 (see Fig. 3). The anchorage bars were then put in place in the anchor pier and connected up to the eye-bar heads, which had been left extending above the masonry at the foot of the well. These bars were carried up and connected to the top of the end compression diagonal, which is held in position by a special steel strut resting on the anchor pier until such time as it receives stress from the weight of the cantilever arm.

The start on the upper portion of the web system, including the top-chord eye-bars, was made on Nov. 12, the traveler moving forward panel by panel toward the main pier as the work progressed. This work went ahead even faster than the lower half of the web system, as the compression verticals were shipped in one length, and very little riveting was required.

Although the longer of the tension diagonals were shipped in two pieces, they were riveted together on the ground before they were erected in place, thus saving time in actual erection.

TOP-CHORD EYE-BAR ERECTION—The top chords are composed of two banks of eye-bars (see Fig. 4). On account of the impossibility of getting eye-bars of sufficient length to span a full panel, they are erected in two lengths, supported on the center by a small lattice truss, thus doing away with redundant members in the web system. The eye-bars are assembled in these trusses in the storage yard, the center pins driven, and the whole panel of eye-bars erected as a complete member; thus only the end pins need to be driven to fully erect a whole section of the chord.

The erection proceeded to panel point 10, or two full panels away from the main pier (Fig. 4), where the work ceased for the season on Dec. 5.

Owing to the excellent equipment of the erection traveler, the members for both trusses were erected simultaneously, which materially expedited the work.

BEST DAY'S WORK—The erection of one complete panel of the upper section of the web, with all pins driven, was the best single day's work during the season.

The St. Lawrence Bridge Co., of Montreal, is the contractor for this work. Phelps Johnson is President; G. H. Duggan, Chief Engineer; George F. Porter, Engineer of Construction; W. B. Fortune, Superintendent of Erection; S. P. Mitchell, Consulting Engineer of Erection.

Cleveland West Side Water-Supply Tunnel

SYNOPSIS—A 10-ft. diameter, 3-mi. tunnel now being driven under Lake Erie from existing crib 1½ mi. offshore to new crib nearly 4 mi. offshore. The tunnel is to be used for additional water-supply of the city. Tunnel being driven with boring tunnel machine in stiff clay. Lining of large concrete blocks placed with special block erector.

The city of Cleveland is now engaged in the construction of a three-mile water-supply tunnel reaching from an existing crib a mile and a half out in Lake Erie to a new crib nearly four miles off shore. While the tunnel work has only just been started, the details of the construction are so novel as to warrant a description of the methods employed.

The first water-supply tunnel for Cleveland was driven from the west side of the city to a crib a mile and a half from shore (see Fig. 1), known as Crib 4. This tunnel was 5 ft. in diameter and was later paralleled by a tunnel 7 ft. in diameter reaching the same crib. Crib 4 and the two tunnels connecting it were abandoned in 1904 for the city water service when the East Side tunnel, from the Kirtland St. pumping station, was completed, although they were continued for power stations requiring only a small supply. The East Side tunnel is five miles long and 9 ft. in diameter, and reaches on a diagonal line to Crib 3. The new tunnel, 10 ft. in inside diameter, is to start from Crib 4 and will extend 16,088 ft. outshore to Crib 5, now under construction. When the system is completed, water from the new intake will pass through the 10-ft. tunnel to Crib 4, whence it will be diverted through the 7-ft. tunnel and through the original tunnel (which is to be enlarged from 5 to 8 ft. in diameter); both of these tunnels come to shore near the new West Side filtration plant now nearing completion, and water from them will be passed through that plant before being delivered to the city mains.

The successive operations in the construction of the tunnel are: The construction of Crib 5; the clearing out of the old 5-ft. and 7-ft. tunnels; the reconstruction of the shafts at Crib 4 to permit the temporary shutting off of the 5-ft. and 7-ft. tunnels, and the construction of a working chamber below for the beginning of operations of driving the 10-ft. tunnel; simultaneous construction of

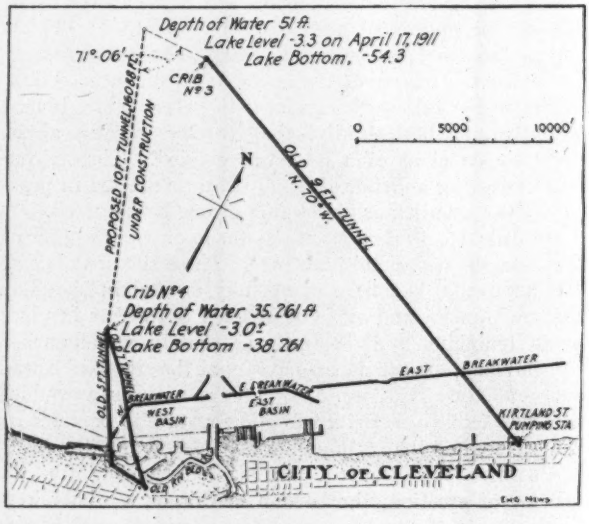


FIG. 1. LOCATION OF WATER-SUPPLY TUNNELS UNDER LAKE ERIE AT CLEVELAND, OHIO

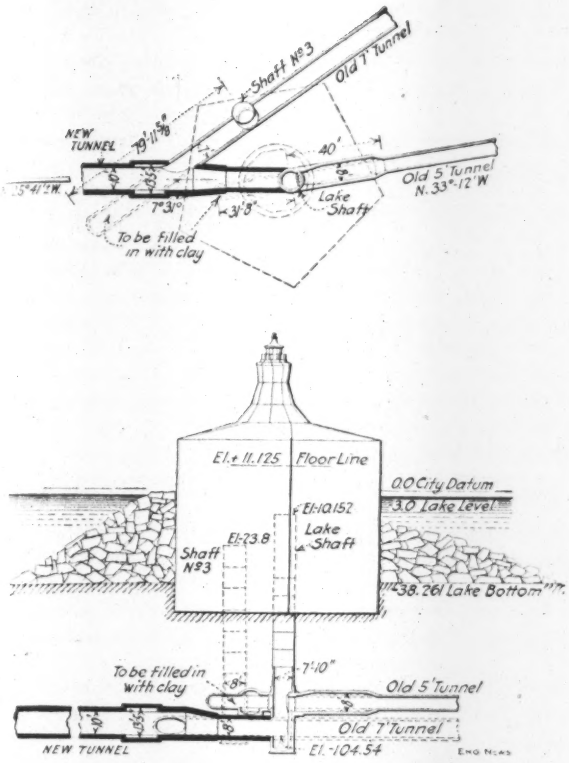


FIG. 2. DETAIL OF CONNECTION OF 5-FT. AND 7-FT. TUNNELS WITH NEW 10-FT. TUNNEL

the 10-ft. tunnel from Crib No. 4 outshore and Crib No. 5 inshore. These will be taken up in detail.

The first steps taken were to extend the two intake shafts of the 5-ft. and 7-ft. tunnels at Crib 4 to about 10 ft. above lake level and open up the shafts of these tunnels on shore prior to pumping out the two tunnels. The 7-ft. tunnel was pumped out first and found to be quite dry, and it has been used and will be used for the transportation of men and material to the Crib 4 working end of the 10-ft. tunnel. A narrow-gage track has been laid in the 7-ft. tunnel and a compressed-air locomotive is used in carrying to and fro the dinkey cars.

Considerable difficulty was experienced in emptying the 5-ft. tunnel and it was finally discovered that there was a large opening at the connection between the tunnel and the uptake pipe at Crib 4. It became necessary to put the uptake shaft at Crib 4 under air and to insert an air lock at the crib end of the 5-ft. tunnel, thereby permitting the building of a bulkhead which will shut off that tunnel until its enlarging operations are started.

From Crib 4 the 10-ft. tunnel was started by driving in a northwesterly direction from the extension of the 7-ft. tunnel beyond Crib 4 and afterward driving, south from this point, an 8-ft. tunnel to connect with the intake shaft of the 5-ft. tunnel on Crib 4 (Fig. 3). At a point about 300 ft. northerly of this shaft a shield chamber about 16 ft. diameter was built. In this chamber a steel shield about 15 ft. long and equipped with 12 hydraulic jacks was erected and the construction of the tunnel with concrete blocks was begun from this point. The shield chamber will be utilized for the building of a two-way air lock.

CONCRETE-BLOCK LINING—The new tunnel is circular in section and 10 ft. in diameter inside a concrete lining, and is a straight line for its whole length—16,088 ft. Its bottom is about 50 ft. below lake bottom, and the depth of water increases from 40 ft. at Crib 4 to 50 ft. at Crib 5. The tunnel will be driven through its entire length in what exploratory borings show to be a good, stiff clay with some included gravel and stone. The investigations tend to show that this clay will be tight enough to allow of work in free air in driving the tunnel, but as a pre-

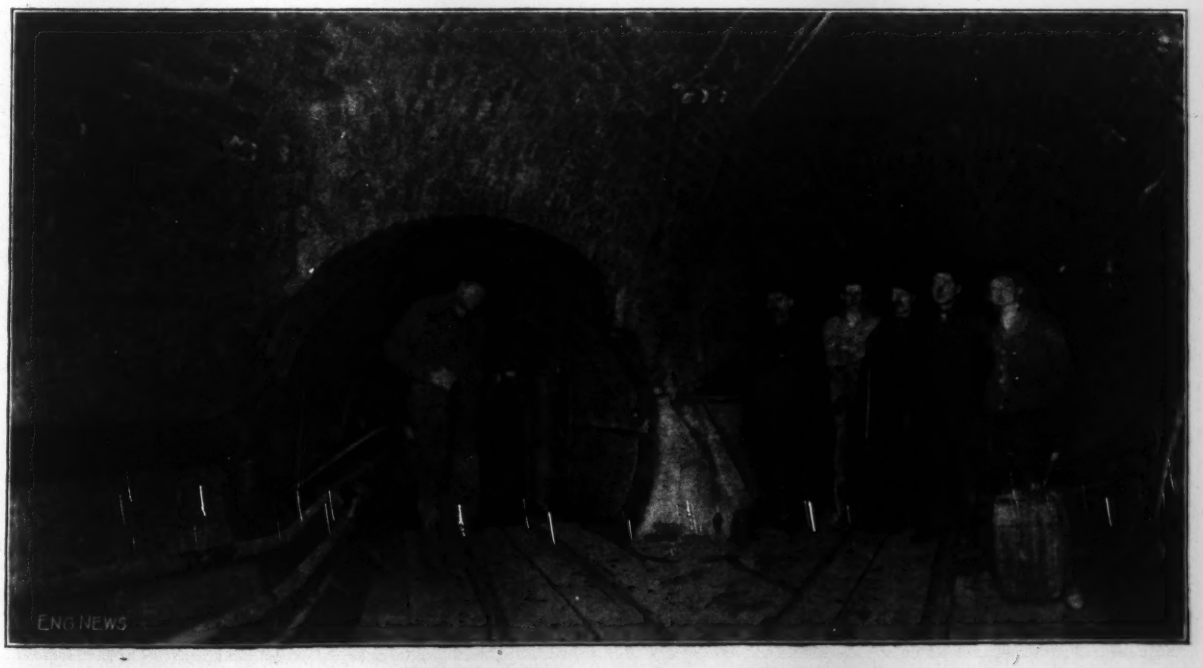


FIG. 3. VIEW OF JUNCTION OF 7-FT. AND 8-FT. TUNNELS
(View taken looking south from the 10-ft. tunnel.)

cautionary measure work has been started under air, but as it progresses it is hoped that it will be possible to take the pressure off.

All of the other water tunnels at Cleveland have been

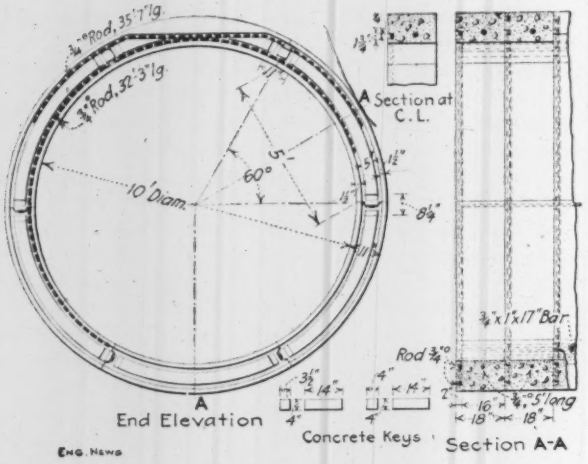


FIG. 4. DETAILS OF CONCRETE LINING BLOCKS FOR WEST SIDE WATER TUNNEL, CLEVELAND, OHIO

lined with brick. In the new 10-ft. tunnel, however, an innovation has been introduced in the way of using a concrete-block lining, except for the first 300 ft., which will be lined with brick so as to have a certain lined length in which to start the concrete-block laying machine. The details of this lining are shown in Fig. 4. It consists of concrete blocks 18 in. deep and 11 in. thick, and of such length as to require six equal-length blocks to the circumference, each block being curved to the proper radius. Each block is reinforced in the center of its depth and about 2 in. from its inner face by one ¾-in. round rod 5 ft. long. In addition, each 18-in. ring is reinforced by two circumferentially placed ¾-in. round rods, which fit into circumferential grooves left in the outer face of each concrete block.

The four side blocks are identical in construction and erection. Each block has what might be called a tenon at one end and a mortise in the other, and they are set up to fit as shown in Fig. 4. The bottom block, however, has two mortises, into which the tenons of the two adjacent blocks are set. The upper block is entirely different from the other five, the groove for the upper reinforcement being carried straight across rather than following the circle of the block itself. This is done so as to carry the reinforcement into the lower part of the block to take care of tension there. This upper block also has two mortises, and the key is made by ramming into the opening between the mortises of the adjacent blocks special precast concrete keys, about 4x4 in. in section and 14 in. long. At the same time the reinforcing rods, which are fitted into the grooves of the blocks, are tied together by sleeve nuts at the key joints, and all the joints and the rods are grouted into place. Each block has holes provided for jaw grip of the laying machine described below.

The block is the design of Walter L. Parmley, of New York City, and has been patented by him. The blocks are being made by the city of Cleveland in a special block factory at the shore end of the old 7-ft. tunnel. They are being poured between special steel molds of standard dimensions, which permit of very easy removal and rapid work. Each block is of a 1:2:4 mix, poured fairly wet and allowed to set for 30 days minimum before being used. They are carried out through the 7-ft. tunnel as needed. The view in Fig. 5 shows the block yard with one line of blocks laid up on the ground.

TUNNELING AND BLOCK-LAYING MACHINE—The tunnel itself is being bored with the tunneling machine controlled by Carpenter & Anderson, of Detroit, Mich., and described in ENGINEERING NEWS, Nov. 5, 1914. The first 300 ft. of the tunnel beyond the air lock was driven by the ordinary tunneling method in order to permit the entrance of the machine. The machine has now been set up and is working. It is intended to start another machine from the lake end of the tunnel when the proper time has arrived, but it has not been done as yet.

The tunneling machine is essentially a huge auger

FIG. 5. VIEW OF BLOCK-CASTING YARD

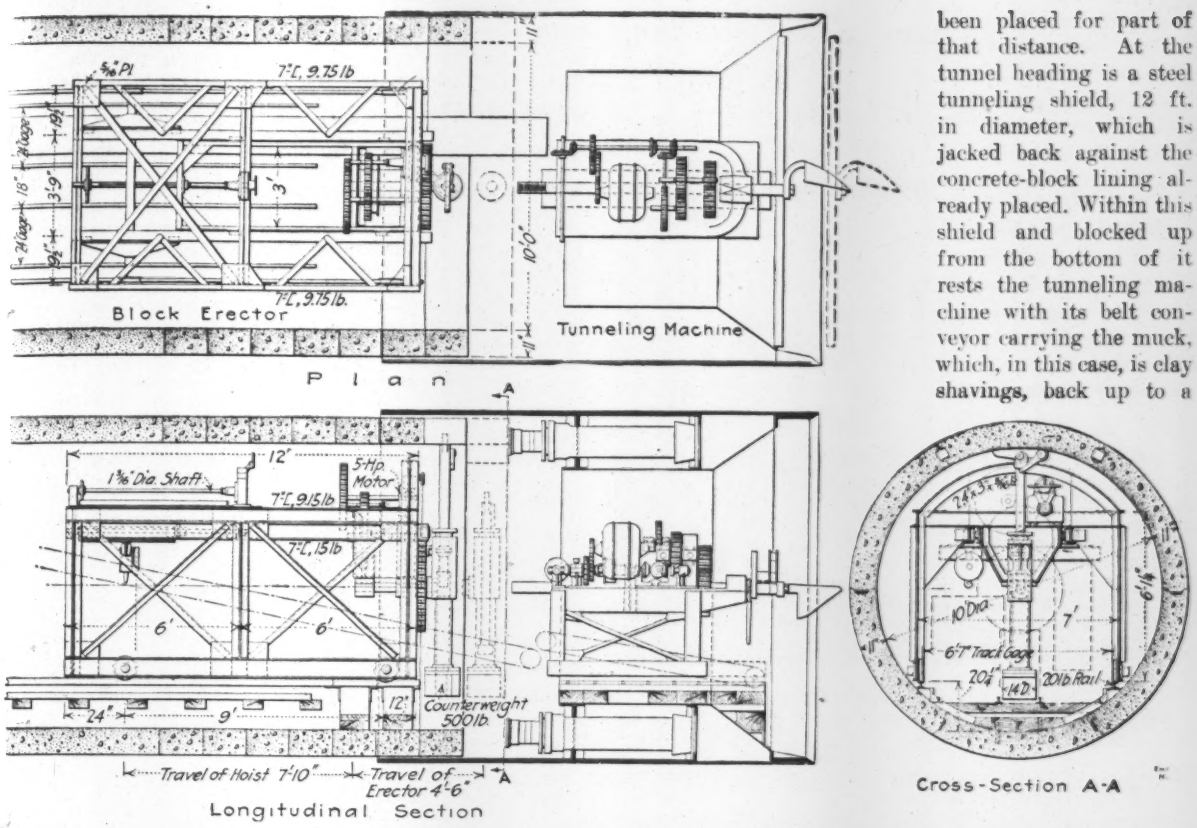


FIG. 6. BLOCK ERECTOR AND TUNNELING MACHINE WORKING IN THE WEST SIDE WATER TUNNEL, CLEVELAND

with an outstanding arm carrying a cutting tool, which, as it revolves, moves outward from the center by cutting a spiral shaving from the tunnel heading. The operation of the tunneling machine and of the block-laying machine which follows it may be noted from a study of Fig. 6. The block-laying machine set up in the shop is shown in Fig. 8.

The operation of the two machines will be described, assuming that they have already been working a certain distance in the tunnel, and the concrete-block lining has been placed for part of that distance. At the tunnel heading is a steel tunneling shield, 12 ft. in diameter, which is jacked back against the concrete-block lining already placed. Within this shield and blocked up from the bottom of it rests the tunneling machine with its belt conveyor carrying the muck, which, in this case, is clay shavings, back up to a dinkey car in the rear part of the tunnel. Immediately back of this machine and blocked up from the concrete lining is the block-laying machine.

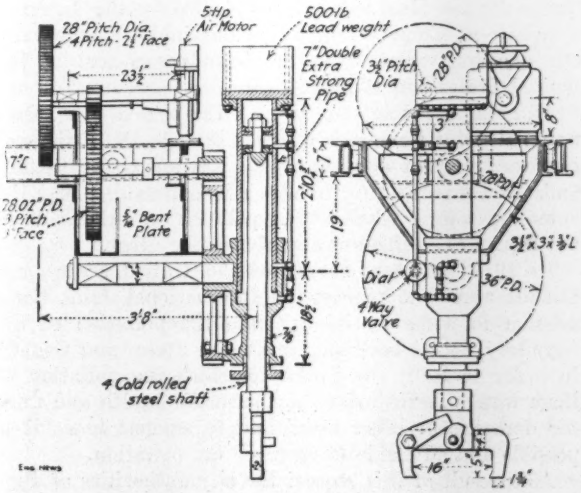


FIG. 7. DETAILS OF MOVING RADIAL ARM ON BLOCK ERECTOR, WEST SIDE TUNNEL, CLEVELAND

This machine essentially is a steel frame mounted on wheels, which carries at its forward end a centrally disposed shaft with a counterweighted diametral arm. This arm is movable back and forward in the line of the tunnel, and has on one end a jaw in which a concrete block may be held and a counterweight on the other end. In it is mounted a hydraulic jack, which controls the motion of the jaw out along the arm. It is also geared to a motor, so that it can be revolved on the central axis. The frame has further a smaller motor, which drives the frame and operates a small hoist, which runs on the upper longitudinal beams of the frame (Fig. 7).

In operation a lining block is brought in from the rear and picked up by the small trolley hoist, run along the frame until taken by the jaw grip of the forward arm. This arm is then turned around until the block is at its proper location in the lining, and the block is shoved into place by operation of the hydraulic jack. This operation is carried out for the five lower blocks of each row of lining. A wooden block is then driven into the key joint and the machine moved along one block. The five lower blocks are then laid in the same fashion in this line, and the wooden key block of the previous line then removed. A key block is then picked up by the jaw arm, the arm pushed out beyond the last lining block, and revolved until the block is in the crown of the curve, and the arm then retracted toward the back of the machine until the key block fits into the

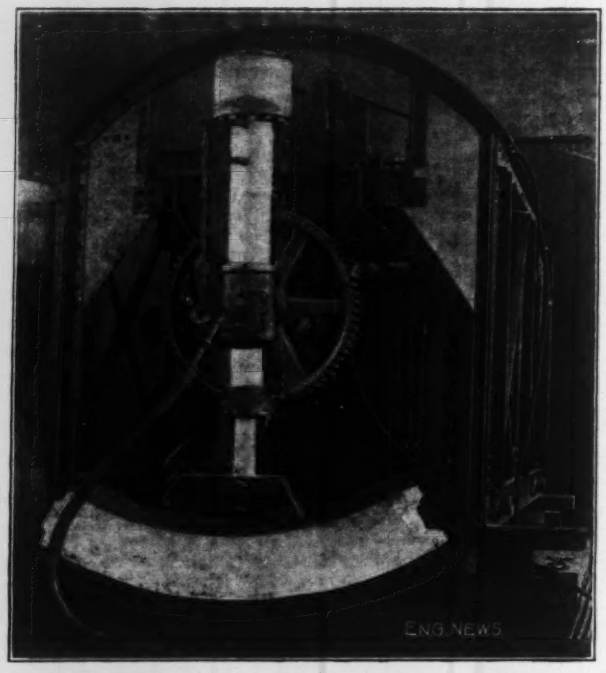


FIG. 8. THE BLOCK-LAYING MACHINE ASSEMBLED IN SHOP WITH ONE OF THE CONCRETE LINER BLOCKS

opening. Reinforcing rods are then placed, and the keys between the various blocks grouted.

When work was first begun with the tunneling machine and concrete-block erector, about 3 ft. per day was built. Since then there has been a gradual increase, the rate of progress now being about 16 ft. per day. It is expected that between 20 and 30 ft. every day will be accomplished in due course of time.

CRIB 5—The construction of Crib 5 was started in 1911, and the crib itself is now complete. The intake shaft is being placed now, but the tunnel driving from this end will not be started until the open weather next spring. The crib is of the usual timber-frame construction, with full complement of boilers, compressors, blacksmith shop and eating and sleeping facilities for 80 men. In the storm of Nov. 9-11, 1913, it was subjected to very severe battering, which shattered some of the framing and caused a practically uniform settlement of 7 ft. in the whole crib. Since that time no marked movement has been observed.

INTAKE SHAFT—The intake shaft is located at Crib 5. This shaft consists of a steel shell made of ¾-in. plates and has an outside diameter of 14 ft. 2 in. at the bottom, tapering from a point about 18 ft. above bottom to a diameter of 13 ft. 8 in. at the top. This steel shell will be lined with a brick wall, built of three rings of brick, making a brick lining approximately 12 in. thick inside of this shell. The lower part of this shaft is provided with a shoe, consisting of steel plates and angle-iron brackets forming a shelf for carrying the brick lining of the shaft. This shaft was designed to be 115 ft. long and was to extend from the main floor of the crib, or 12 ft. above lake level, to about 103 ft. below lake level, the depth of water at this point being 50 ft. In sinking this shaft soft clay was encountered, and it has already been sunk to a depth of 113 ft. below lake level and is now awaiting the arrival of an additional cylinder 6 ft. long, when it will be sunk to about 121 ft. below lake level, or approximately 18 ft. lower than originally planned. The following paragraphs of the specifications give a description of this shaft:

> At 10 ft. above the cutting edge of the cylinder there shall be an opening in the shell, for the eye of the tunnel. This opening shall be provided with a flange of cast steel riveted to the shell, with the joints calked and made water-tight. This flange shall be drilled for bolts 1⅛ in. diameter. This opening shall be closed during the sinking of the shaft with a removable steel-plate cover ¾ in. thick, made with a cast flange bolted to the flange of the opening and made perfectly water-tight. These flanges shall be faced for water-tight joints; this cover to be made in four sections with internal joints. In the center of this steel cover a manhole and cover shall be provided.
>
> As the shaft is forced down below the bottom of the lake the earth inside the shaft shall be excavated by means of an orange-peel type of dredge and without removing the water from the shaft until the shaft has been sunk to such depth as in the opinion of the superintendent may be necessary to insure that the water will not follow down the outside of the shaft and enter below the cutting edge. The dredge shall be small enough so that excavation in the shaft may be regulated and carried on not only at the center, but also the circumference of the shaft if this should be found necessary. The shaft must be maintained in a truly vertical position throughout.

PERSONNEL

The West Side tunnel is being built under force account by the City Water Department of Cleveland. C. F. Schulz is commissioner of water and in main charge of the work, and his assistants are Messrs. C. P. Jaeger, deputy commissioner; S. E. Roof, engineer of construction; G. C. Van Dusen, superintendent of tunnel construction.

Buffalo Sewage Disposal and Water-Supply in Relation to the Pollution of the Great Lakes

The sewage disposal and water-supply of the cities of the Great Lakes, both in the United States and Canada, has been a matter of concern of late. Besides the attention given to the subject by individuals, cities, groups of cities, private associations, and state boards of health, extensive studies have been conducted by the United States Public Health Service and also by the International Joint Commission, which has in its charge various questions relating to the boundary waters of the United States and Canada.

The reason for this inquiry on the part of the International Joint Commission lies in Article IV of the waterways treaty of Jan. 11, 1909, between Great Britain and the United States, in which it is provided that the boundary waters "shall not be polluted on either side to the injury of health or property on the other."

In 1912 the governments of the United States and Canada agreed to request the International Joint Commission to make an inquiry into the pollution of the boundary waters between the United States and Canada in order to learn the extent to which the pollution of these waters is "injurious to the public health and unfit for domestic or other uses" and to suggest how "it is possible and advisable to remedy" the pollution.

As a result of this request the city authorities of Buffalo, and presumably of other cities as well, were invited to coöperate with the Commission in making inquiries

on the subject. The request addressed to Francis G. Ward, Commissioner of Public Works of Buffalo, dated Sept. 9, 1912, was referred to Geo. H. Norton, Deputy Engineer Commissioner of Buffalo. On Oct. 8, 1912, Mr. Norton reported on the questions raised as to the cause, extent and remedies of pollution.

Mr. Norton stated that Lake Erie and the Niagara River are polluted by the sewage and street drainage of Dunkirk, Lackawanna, Buffalo, Tonawanda, North Tonawanda and Niagara Falls, and of smaller places, practically all the sewage from which enters these boundary waters or their tributaries without treatment. On the Canadian side the pollution is believed to be the same in character, but less in extent.

The effect of this pollution on the public health is a subject on which there is "a wide diversity of opinion." The typhoid records indicate that this pollution causes some injury to health, but that a proper location of water-works intakes and the chlorination of the water would reduce or largely remove the danger.

Neither sewage treatment nor the diversion of sewage from these waters is an economically practicable means of preventing any dangers that might arise from the lake water, and no matter how well these were carried out there would still remain the pollution from the surface drainage of the tributary area as a whole.

Unquestionably water-supplies need to be protected in "the interest of public health and decency, and to such an extent as the resources of the affected communities" warrant, taking into account not alone the burden of taxation but also "how much purification" the district can "afford in relation to other demands for improvement of health and well-being."

Mr. Norton expressed the belief that water-supply and sewage disposal are so interrelated at Buffalo and vicinity as to make it imperative that they be considered together. He was also of the opinion that additional and expert studies of water-supply and sewage-disposal conditions in the Buffalo district were needed, to determine "what is most economical for all, and what should be done by each of the several interested communities."

At a hearing before the International Joint Commission, in Buffalo, on Sept. 26, 1914, Mr. Norton again voiced the objection of Buffalo to any action by the Commission which did not consider the water-supply as well as the sewage disposal of the city. He called particular attention to the fact that in the 31 months from the opening of the new water-works intake at the head of the Niagara River, and with a partial but decreasing use of the old intake, the typhoid death rate of the city fell from an average of 26 to 13 per 100,000. He added that a "complete liquid chlorination plant was placed in use at the new intake on Apr. 27, but sufficient time had not elapsed to note results." With future provision for the removal of autumnal turbidity from the water and for chlorination at the old water-works intake during the occasional use of the latter, Mr. Norton appeared to think that Buffalo would have made reasonable provision for the protection of its own water-supply.

As to sewage disposal, a plan had been completed, Mr. Norton stated, for diverting the sewage of Buffalo from the inner harbor to the main outlet into the Niagara River. In addition, contemplated plans provide for sewers for territory in the southwestern part of the city now without sewers, with treatment to prevent nuisance on the discharge of the sewage into the outer harbor, inside the government breakwater.

Mr. Norton expressed his belief that it would be economically impracticable for Buffalo and the other Niagara River municipalities to so treat their sewage as to bring the water of the lower Niagara within the safe limits of burden for water filters, as set up by the consulting engineers to the International Joint Commission in its report of 1914.

Niagara Falls has already made an advantageous change in the location of its water-works intake and is treating its water-supply. As for Tonawanda and Lockport, the data are insufficient.

The three cities of Niagara Falls, Tonawanda and Lockport have a combined population of only about 40,000, and it seems unfortunate that they should have three separate water-works. A single filtration plant could be operated at less expense than three plants and with a single filtration plant "constant expert supervision beyond the reach of three separate plants" could be afforded. It might be that Niagara Falls could supply the other two cities, in fact the whole lower frontier, at favorable water rates. Or, since it is only nine miles from the Buffalo pumping station to the Tonawanda and Lockport, it might be advantageous to all concerned for Buffalo to supply water to those cities.

In any event it appears that if Buffalo would remove from its sewage a fair proportion of the solids "reasonable protection would be given to filtration plants for the water-supply of Tonawanda, North Tonawanda and Lockport," and "that present conditions impose no unreasonable burden upon the water plant at Niagara Falls" or upon any other communities. There should always be kept in mind the "sanitary functions of the Niagara River as a natural resource both for water-supply and sewage disposal."

Subsequently to Mr. Norton's statement of Sept. 26, 1914, the International Joint Commission asked the various cities along the international boundary to give it information regarding their financial condition, and also to submit estimates of cost of certain changes in sewage collection and disposal. In response to this request, Mr. Norton, on Nov. 23, 1914, made rough estimates in answer to three questions, as follows:

(1) Cost of additional collection to make sewage treatment possible, $1,650,000.

(2) Cost of plant for fine mechanical screening, $2,160,000.

(3) Cost of plant for two hours of sedimentation of minimum dry-weather flow, $7,430,000.

That is, changes in collection and a screening plant would cost $3,810,000; or changes in collection and a plant for two hours' sedimentation would cost $9,080,000. These items take no account of future growth. They provide for sewage-works at three different locations.

Engineers as Public Service Commissioners—Most of the framers of the laws establishing state control of public utilities were political climbers, and they cashed early on their opportunity, leaving the operations of the laws in the hands of men of mixed qualifications. A most singular fact is that the one profession that should have been placed in charge of the commission idea—regulation being a strictly engineering proposition—has been practically ignored in the appointments, for most of the regulators are lawyers, statisticians and political hangers-on. Engineers are conspicuously absent.—Raymond S. Carroll, in Philadelphia "Public Ledger."

The 12th St. Double-Deck Viaduct at Kansas City

SYNOPSIS—A reinforced-concrete viaduct 2265 ft. long and having a maximum height of 110 ft. across the bottom lands of the Kansas River at Kansas City, Mo. Details of design and construction.

At Kansas City, Mo., there has long been need for a direct means of communication between the commercial and business district on the high ground, and the low-level bottom lands of the Kansas River where are located the stockyards, packing houses and a large part of the freight houses, factories and wholesale warehouses. Both of these districts are on the line of 12th St., but are separated by a steep bluff, so that vehicle traffic has to go north to 6th St. or south to 17th St. to secure practicable grades. The only direct communication has been the last line of the old cable railway system, operating over a dilapidated steel viaduct having a grade of 14%, which was considered too steep for electric cars.

About four years ago, the city provided funds for the construction of a viaduct to connect these two business centers, and in September, 1913, a contract was let for a double-deck reinforced-concrete structure, which is now under construction. It will be completed and ready for traffic about the end of 1914, and its total cost will be about $625,000, exclusive of the cost of land and the removal of the old steel structure. This reinforced-concrete viaduct was designed by Waddell & Harrington, Consulting Engineers, of Kansas City, Mo., who are also supervising its construction. The Graff Construction Co., of Seattle, Wash., is the contractor. The design is shown in Fig. 1.

General Design

Three special features of the design are the double-deck construction, the bowstring-arch span and the arrangement of the upper deck. The viaduct consists mainly of girder spans of 33 to 56 ft. It crosses a group of railway tracks, however, by an arch span of 149 ft.; this has two arch ribs, with spandrel columns supporting the upper deck, and hangers carrying the lower deck at the springing level. The upper deck is 60 ft. wide over all, but it is carried by two rows of columns and longitudinal girders spaced laterally 37 ft. c. to c. The double-deck electric railway occupies one side of the deck; with its center line coincident with that of the girders, and consequently the girders and columns on this side are heavier than those on the opposite side. This is shown in Fig. 2.

The structure is designed for live-loads as follows: 1, On the railway tracks, 50-ton cars; 2, on each roadway, a 15-ton steam roller and 120 lb. per sq.ft.; 3, on the sidewalk, 100 lb. per sq.ft.; 4, wind pressure of 30 lb. per sq.ft. on the loaded structure.

The viaduct has a total length of 2265 ft. (exclusive of embankment approaches) and a maximum height of 110 ft. at the foot of the bluff. The upper deck provides a 30-ft. roadway for vehicular traffic, a double-track electric railway on a 21½-ft. independent right-of-way, and a single 5-ft. sidewalk. This deck rises from Liberty St. in the river bottoms on a uniform grade of 5.527% to meet 12th St. on top of the hill at Summit St. The lower deck provides a clear roadway 30 ft. wide, and rises from Hickory St. (one block further east than the beginning of the upper deck) on a variable grade of approximately 3%, and ends at Beardsley St., about half-way up the hill. This street is to be continued north and south up the face of the bluff on about 3% grade, thus providing an indirect but low-grade street for team traffic, and avoiding crossing at grade the many tracks in the river bottom. Reinforced-concrete stairways afford access to the upper deck of the viaduct at three cross-streets.

From Liberty St. to Santa Fé St. (the three blocks at the west end of the viaduct), 12th St. was 30 ft. wide and 11th St. 70 ft. wide, while the two were only about 30 ft. apart. The narrow intervening blocks were purchased or condemned and the viaduct was deflected by a reverse curve from the center line of 12th St. to the center of the area made up of the two streets and these narrow blocks, thus retaining 11th and 12th Sts. for traffic. Very shallow floors are employed in both decks immediately over the cross-streets, and over the railway tracks, thus securing sufficient clearance to maintain traffic on all streets which cross the viaduct.

Foundations

The bottom lands consist of fine sand and sandy clay, and reinforced-concrete piles are used for all foundations except those at the bluff. The plans provided for premolded piles driven in the usual way, with the assistance of a water jet. The contractor had the option of using any approved form of pile, however, and he preferred to use piles cast in place. The specified average load per pile in each base was 25 tons, with a maximum of 35 tons considering effect of wind, temperature changes and deflection of cross-girders. For bases without piles, supported on rock, the average loads were 6500 to 10,000 lb. per sq.ft., the maximum (under extreme conditions) being 9000 and 14,000 lb., respectively.

The columns are carried on shallow bases or footings, which inclose the heads of the piles and are well tied to them (Fig. 1).

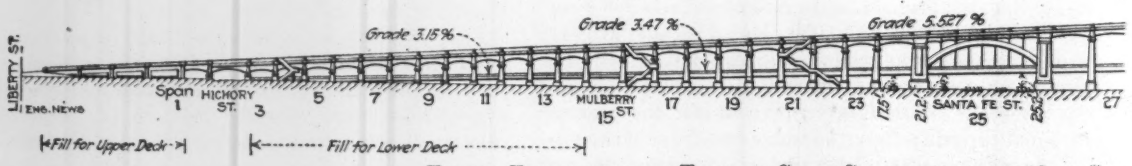


FIG. 1. ELEVATION AND TYPICAL CROSS-SECTION OF THE 12TH ST.

FIG. 2. THE 12TH ST. VIADUCT AT KANSAS CITY, MO.
(Showing construction work in progress for the upper deck.)

SUPERSTRUCTURE

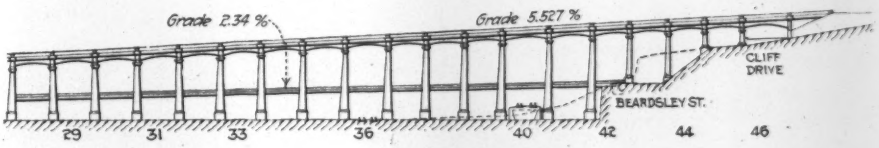
The columns are rectangular, 5 to 6 ft. long at the top, with a transverse width of 51 in. for the north and 36 in. for the south columns; this is the width of the girders, the north girders being heavier because the railway tracks are carried by them. The batter of the columns is ⅛ in. per foot on all sides. The lower parts of the columns have on each narrower face a rectangular pilaster, to carry the longitudinal girders of the lower deck. The pilasters project 12 in. from the column, and have a face batter of $\frac{3}{16}$ in. per ft., while the width is from 20 to 24 in., depending upon the width of girder which they carry.

The expansion columns at expansion ends of the lower-deck girders have slots or recesses 4 in. deep to receive the ends of these girders. The column reinforcement consists of vertical bars and horizontal hoops.

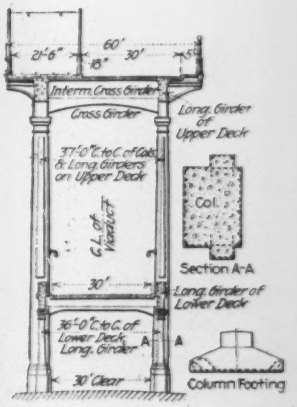
The tops of the columns and pilasters at the expansion ends of the longitudinal girders have ¾-in. bearing plates, planed on the top surface. The two plates on the top of the column (and the two on its pilasters) are connected by a pair of horizontal angles 3x3½ in., embedded in the concrete.

The upper deck consists of 45 deck girder spans varying in length from 33 ft. to about 56 ft.; a bowstring-truss span 151 ft. c. to c. piers, and earth-filled approaches. The lower deck consists of 27 through girder spans (supported by the same columns that carry the upper deck), the bowstring-truss span, and earth-filled approaches. The girder spans are supported on columns spaced 37 ft. c. to c., whereas the piers supporting the truss span are 40 ft. c. to c. The upper-deck girder spans consist of two main girders with cross-girders, cantilever brackets, and floor slab, while the lower-deck girder spans consist of two through girders with the usual floor-beams and deck slab.

To obtain a minimum depth of floor, steel girders em-



DOUBLE-DECK REINFORCED-CONCRETE VIADUCT AT KANSAS CITY, MO.



TYPICAL CROSS-SECTION

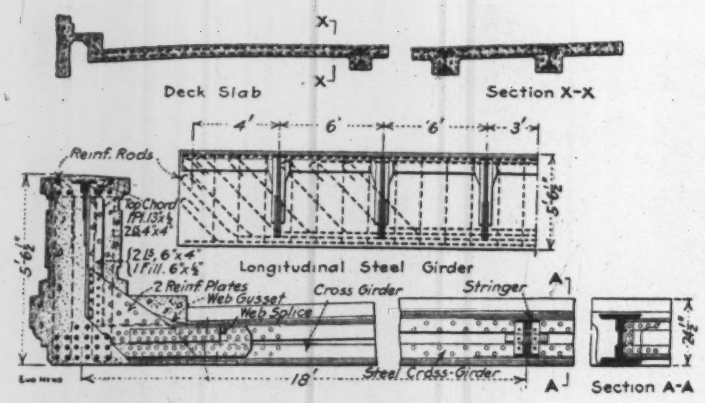


FIG. 3. STEEL GIRDER AND SHALLOW FLOOR INCASED IN CONCRETE FOR THE MULBERRY ST. SPAN

bedded in concrete are used instead of the usual reinforced-concrete longitudinal girders in spans Nos. 1 and 2 of the upper deck at Hickory St., and in the lower deck for span No. 15 at Mulberry St. Between the girders are cross-girders composed of a web plate, four flange angles and cover plates, and between these are stringers of the same section, but shallow enough to fit between the flange angles. Horizontal gusset plates are fitted at the intersections of this framing and have holes to which the wire-cloth reinforcement of the slab is wired. This is shown in Fig. 3.

The longitudinal girders of the upper deck are made continuous over three spans, with cast-steel shoes for the expansion bearings at the ends, and resting directly on the two intermediate columns, as shown in Fig. 4. Between these are the cross-girders (Fig. 5), in line with which are the cantilever brackets supporting the overhanging portions of the slab deck. The longitudinal girders of the lower span are in one-span lengths, as they fit between the columns and rest upon the pilasters.

To give a good appearance to the structure, the girders of the upper deck, and the cross-girders and cantilever brackets are curved, while the retaining-walls and the lower-deck girders are paneled.

The thickness of the upper-deck slab is 9 in. for the railway, 8 in for the roadway and 4¼ in. for the sidewalk, this last including the ¾-in. wearing surface. The railway portion has two curbs to retain the ballast, and the sidewalk has a fascia girder beneath its outer edge. The lower deck has an 8-in. slab.

The deck slab is covered with a waterproofing course, provision being made to prevent it from breaking at the expansion joints. For the roadway, the surface is first covered with a concrete primer; then a layer of open-mesh burlap mopped in place with waterproofing pitch, covered with a layer of asphaltic felt covered with the same pitch and given a sand finish. On this is the 1½-in. sand cushion for the 4-in. wood-block paving. For the track deck, the same plan is used, but with two layers of burlap, and the asphaltic felt is covered with 1 in. of asphaltic mastic coated with waterproofing pitch, which is given a sand finish. In both cases the felt is turned into a groove in the concrete and sealed with pitch for the roadway and mastic for the track deck. The gutters drain to curb inlets, with 12-in. drain pipes.

THE BOWSTRING SPAN

The 149-ft. span over the railway tracks at Santa Fé St. has its arch ribs and piers 40 ft. c. to c. transversely. Its construction is shown in Figs. 6 and 7. Its bowstring trusses consist of reinforced-concrete arch ribs with eye-bar bottom chords and built-up steel hangers. The lower deck

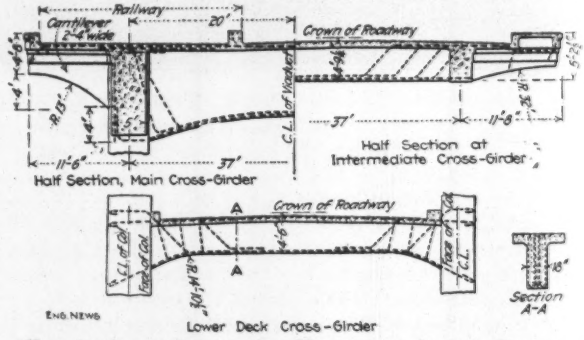


FIG. 5. CROSS-GIRDERS OF UPPER AND LOWER DECKS

has 20-in. I-beams across the roadway, carried on 24-in. I-beams, which are connected to the hangers. The upper deck is similar to that in the rest of the structure. The eye-bar bottom chords are connected at their ends to shoes which are each composed of three webs, connected by U-

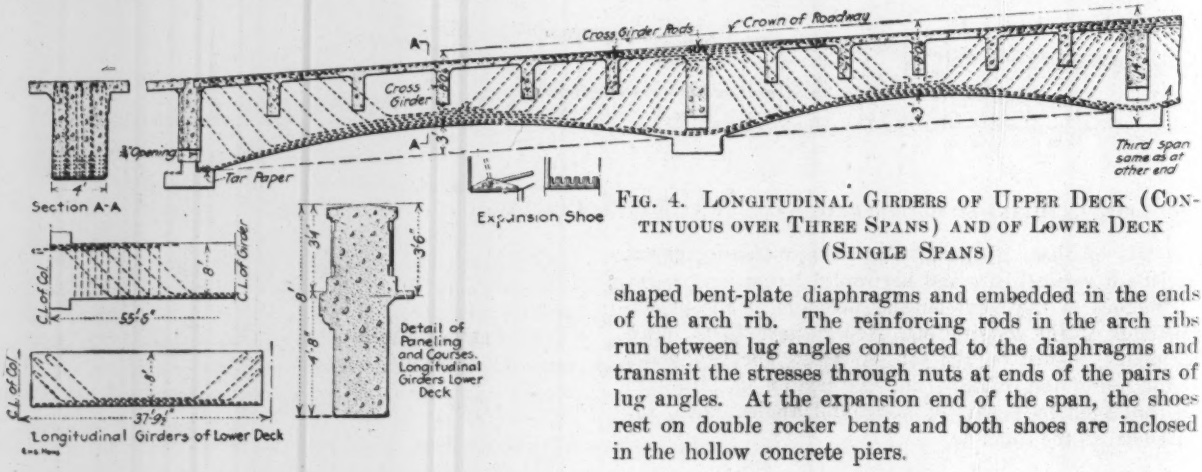


FIG. 4. LONGITUDINAL GIRDERS OF UPPER DECK (CONTINUOUS OVER THREE SPANS) AND OF LOWER DECK (SINGLE SPANS)

shaped bent-plate diaphragms and embedded in the ends of the arch rib. The reinforcing rods in the arch ribs run between lug angles connected to the diaphragms and transmit the stresses through nuts at ends of the pairs of lug angles. At the expansion end of the span, the shoes rest on double rocker bents and both shoes are inclosed in the hollow concrete piers.

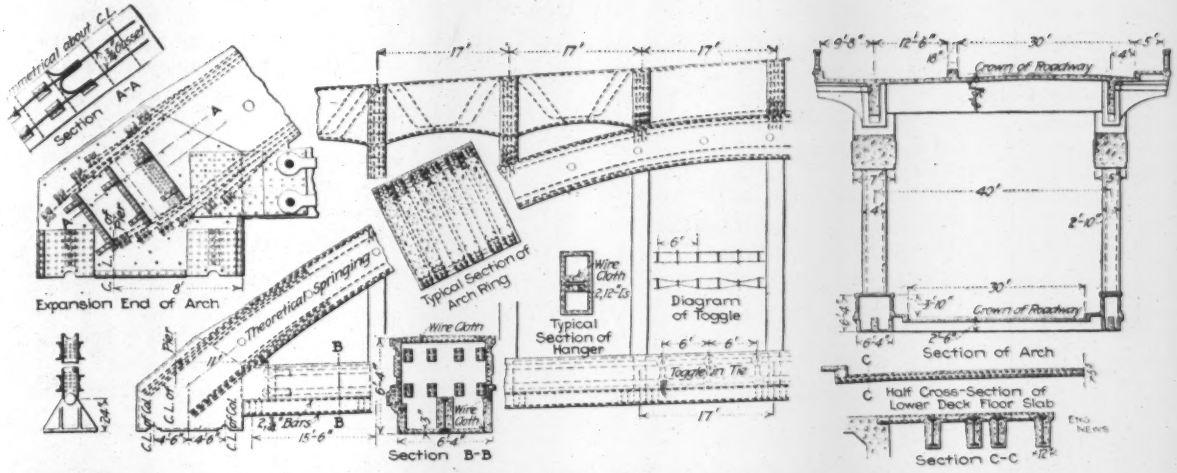


FIG. 6. DOUBLE-DECK ARCH OF 149-FT. SPAN; 12TH ST. VIADUCT AT KANSAS CITY, MO.

The eye-bar chords were drawn together by toggles (Fig. 6) as the falsework was removed, thus shortening them enough to compensate for their own elongation and for the shortening of the arch rib under the dead-load plus half the live-load. The eye-bars were then inclosed in concrete to protect them from rust, and a reinforced-concrete box was built about them to maintain the appearance of continuity of the through reinforced-concrete girders which carry the remainder of the lower deck. The steel floor-beams are also incased in concrete (placed in forms) to protect them from the locomotive gases. Fig. 7 shows the arch under construction.

PAVING AND TRACK

The highways of both decks are 30 ft. wide with 3-in. crown, and are to be paved with creosoted wood blocks.

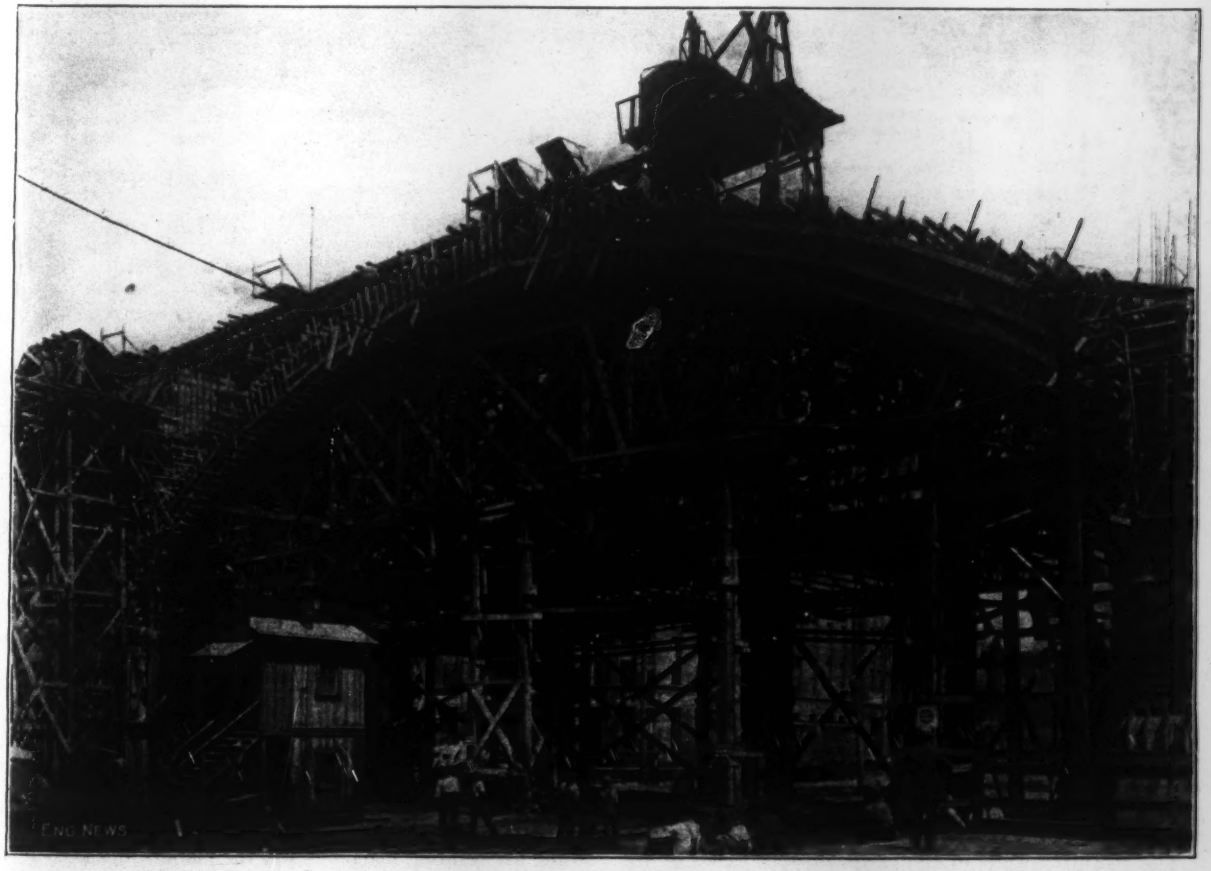


FIG. 7. FALSEWORK AND RIB FORMS FOR 149-FT. ARCH (AT SANTA FÉ ST.) ON THE 12TH ST. VIADUCT AT KANSAS CITY, MO.

(The derrick car and concrete cars are on a trestle above level of roadway.)

As the grades are rather steep for such paving, the foothold for horses is secured by separating the rows of blocks transversely about ⅜ in. by creosoted lath at the bottom, and tar and fine gravel at the top. The gravel is heated immediately before being placed to prevent rapid cooling of the tar, thus making sure that it will fill the interstices in the gravel. This pavement has been used very satisfactorily on grades up to 6%. The paving will be laid on a 1½-in. sand cushion upon the concrete deck, or upon a 6-in. concrete base on the earth-fill approaches.

The electric railway tracks are spaced 10 ft. c. to c., and will be laid with 80-lb. T-rails, with inside guard rails for the full length of the structure.

Miscellaneous

The hand rails or parapet walls are 3 ft. 6 in. high, with 5-in. openings 9¾ in. c. to c. The panels are mainly about 7 ft. 6 in. (8 ft. on the arch span), and the expansion ends are tenoned to fit mortise joints or recesses in the pedestals.

The trolley poles are of steel, 21 ft. high above rail level. The lamp posts, alternating with the trolley poles, are of cast iron, 6 ft. high from top of parapet wall, and each will have a 14-in. globe. On the lower deck the lamps will be carried by cast-iron brackets 2 ft. long, attached to the faces of the columns.

The retaining walls of the earth-fill approaches of the upper deck are of the counterfort type, while those of the lower-deck approaches are of gravity section.

The stairways are 5 ft. wide, and consist of a pair of concrete side girders and bottom slab, the slab forming the steps. The landings are supported either by cantilever brackets from the columns, or by a single central column.

Materials and Construction Plant

The concrete in hand rails and stairs is 1 : 1½ : 3, using stone which will pass a ¾-in. ring. All other concrete is 1 : 2 : 4, using 1¼-in. stone.

The concreting plant consists of elevated bins from which the materials are run by gravity, into the 1-yd. mixer and a double-track shuttle cable railway, which delivers the concrete to spouts from a trestle placed somewhat above the upper deck of the viaduct. The sand and broken stone are delivered to the pit by hopper-bottom cars, thence hoisted to the bins by a link-belt conveyor. The cable railway is lengthened as the structure proceeds, and as the falsework is removed the tracks are lowered and carried directly on the viaduct.

The mixer delivers its charge directly by gravity into the side-dump cars of the shuttle cable railway, and two cars on each track give ample capacity for the work. The hoisting engine is so situated near the top of the material bins that its operator has full view of the mixer and of the entire length of the cable railway. The form work is handled by a traveling derrick on each deck.

The entire plant is electrically operated. This applies to the bar-bending machines and the planers and saws for the form work, as well as the hoists, cable railway, and mixer.

The first-page view shows the work under construction.

Fig. 8. Deck of the 12th St. Viaduct at Kansas City, Mo.

(At the left is the space for electric tracks, with roadway adjacent and sidewalk on the right. The wider platforms in the foreground are for stairways to cross streets.)

ith the derrick car and trestle on the upper deck, and portion of the completed viaduct (including the arch pan). Fig. 8 is a view from above, showing the construction railway (cable operated) and the deck slab with platforms for stairways. It shows also the jog in the line of the viaduct.

Municipal Steamboat Landing at Peoria, Ill.

The steamboat landing at Peoria, Ill., on the Illinois River, was originally a bulkhead wall, and the handling of freight to and from the boats was inconvenient, owing to the varying stages of the water level. The city decided to improve conditions by removing this bulkhead for a length of 1350 ft. and building a sloping paved bank or levee, from which gangways could be laid to the steamboats at any stage of the water. At present this has been built for about 850 ft., with a retaining wall at the end to support the bank. The construction is shown in Fig. 1.

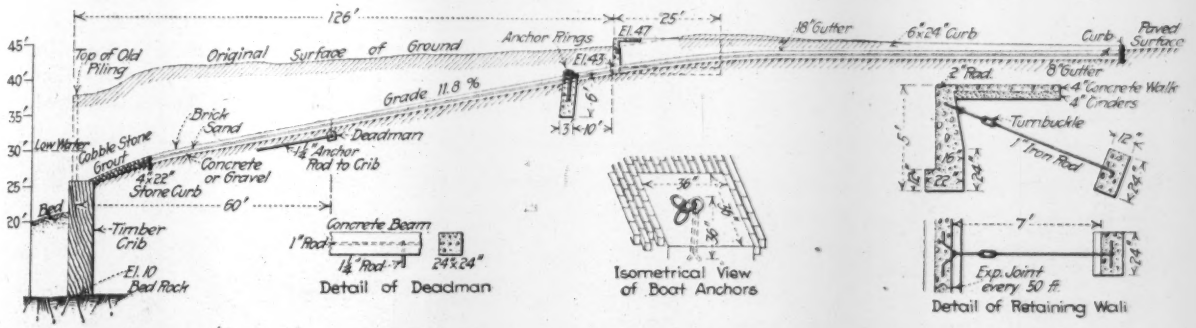


FIG. 1. CROSS-SECTION OF NEW STEAMBOAT LANDING OR LEVEE AT PEORIA, ILL.

The original design provided for a dock wall of ordinary pile and sheetpile construction along the river front of the levee, but an alternative design was proposed by the lowest bidder on the work, which would effect a saving of about $15,000 by utilizing the sound piling from the old dock wall. This plan was adopted. The method of construction was to build timber cribs, with lengths of old piling for the horizontal members, as shown in Fig. 2. The cribs are made interlocking, as shown by the plan, alternate cribs having the front face longer than the back face. These cribs were filled with stone, sunk in place, and anchored by 1-in. rods leading to a concrete beam or deadman.

A dipper dredge was used to pull out the old dock wall or bulkhead and to dredge the seat for the cribs. About 45,000 yd. of material was excavated, 60% of this being taken out with the dredge, loaded on dump scows and towed across the river for disposal. The balance of the excavation and the backfilling around the cribs was done by means of a traveling derrick with an 85-ft. boom handling a 1-yd. clamshell bucket. The concrete for the retaining walls, paving, etc., was put in with a mixer having a capacity of ⅓ cu.yd.

The slope of the levee has proved very satisfactory, and it is said that the river men claim this to be the easiest levee along either the Illinois or Mississippi rivers for landing or unloading their cargoes. The slope is not as steep as customary, and it is possible for teams to get down to the boats and up to the streets without the usual difficulties encountered on steep levee slopes. That portion of the levee above the low-water mark is paved with old paving blocks which had been taken up throughout the city.

The general design of the levee was prepared by L. D. Jeffries, City Engineer, Peoria, Ill. The special crib construction was designed by John T. Walbridge, of the John T. Walbridge Engineering Co., of Chicago, who had the contract for the work.

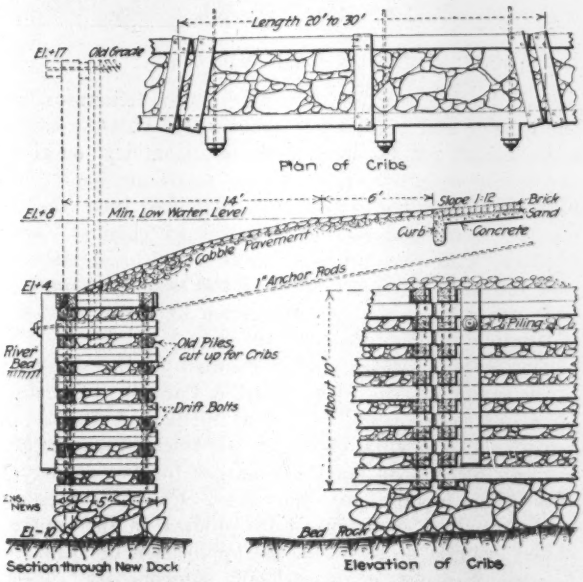


FIG. 2. INTERLOCKING ROCK-FILLED TIMBER CRIBS FOR THE RIVER FRONT OF THE LEVEE AT PEORIA, ILL.

Remarkable Growth of the Good Roads Movement—More than 34,000 miles of surfaced roads have been constructed during 1913 and 1914 and during the ten-year period from 1904 to 1914 more than 96,000 miles were completed. In 1904 there were only 153,000 miles of surfaced roads of all types in the United States. The average mileage constructed per annum during the past ten years is 9600 miles, but the total completed in 1914 exceeds 18,000 miles. About 30,000 miles of highway have been completed with the aid of state funds of which over $200,000,000 have been expended. The state aid movement began in 1892. Only recently has it gotten well under way. The results accomplished for 1913 and 1914 comprise a total of 10,000 miles of state aid highways completed, or in two years time one-third of the entire mileage constructed with the aid of state funds has been completed. Only six states now, out of a total of forty-eight, are without state highway departments, and thirty states have granted money aid to the building of roads.—From the 1915 "Good Roads Year Book" of the American Highway Association.

The Cyanamid Works at Niagara Falls

SYNOPSIS—Present status of the artificial-nitrates industry is reviewed with particular reference to the cyanamid process. The technique and plant developed for American conditions are outlined.

NITROGEN FROM THE ATMOSPHERE—The discovery of practicable processes for the fixation of atmospheric nitrogen is called by many the most notable scientific achievement of the present age. Due to the demand for nitrogen in an available form for agriculture and the arts and to the previous limited supply and consequent high price, any practicable means of securing for the use of man the nitrogen in the vast stores of the earth's atmosphere is of interest and importance.

It has been known for some time that the American Cyanamid Co., in its factory located at Niagara Falls, Canada, was commercially active in the fixation of atmospheric nitrogen by the Frank-Caro process. The general scheme of this process has been widely discussed for several years in technical journals, but its application at the American plant has been little noted in such discussions in spite of the unusual interest which such an industrial project arouses. Therefore, the following brief notes on the works and its product are offered.

Briefly stated, the general principle of the Frank-Caro process is as follows: Calcium carbide (CaC_2) when raised to a temperature of 1100° to 1200° C., and supplied with nitrogen gas, will combine with the nitrogen and form calcium cyanamid ($CaCN_2$), the reaction being exothermic. Carbide, it will be remembered, is

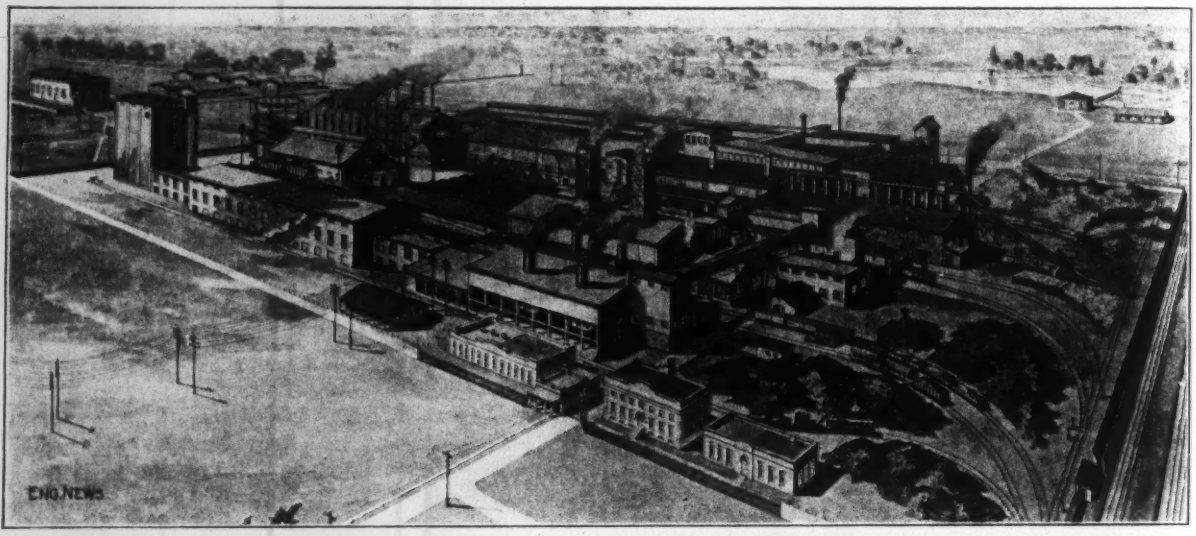


FIG. 1. BIRDSEYE VIEW OF NIAGARA FALLS WORKS; AMERICAN CYANAMID CO.

Three radically different processes are available today. The first produces nitrous oxides in the electric arc, and this is the basis of the Birkeland & Eyde[1] and the Badische Analin & Soda Fabrik[2] systems. A second is the Haber scheme of producing ammonia by the direct synthesis of hydrogen and nitrogen under extreme pressures in the presence of a catalytic agent.[3] The third, or Frank & Caro, system gives calcium cyanamid through the direct absorption of nitrogen by calcium carbide. The arc process is particularly adapted to the cheap water powers of Norway, and the process is used only in that country. By it are made nitric acid and nitrate of lime. The Haber ammonia process is still under development. The cyanamid process is the most efficient one now available and is employed all over the world, plants now being in commercial operation in practically all of the large countries where markets exist and water power is available.

formed by the reaction between lime (calcium oxide) and coke or coal (carbon) at about 2600° C. Cyanamid, as marketed for fertilizer purposes, is a dry, odorless, non-hygroscopic, blue-black powder, analyzing about 19% nitrogen, 12% free carbon, and 20% free lime, the remainder being calcium and carbon in chemical combination with the nitrogen, plus small quantities of iron and alumina, etc. The material is neither combustible nor a supporter of combustion and can be stored indefinitely without loss of nitrogen.

The research which finally resulted in the discovery of the cyanamid process by Frank & Caro was carried on for about twelve years, backed by Siemens & Halske, of Berlin. The original object of this research was to find a cheap method of making cyanides for the extraction of precious metals from their ores. Calcium cyanamid was evolved as an intermediate product in the contemplated cyanide process, and the application of cyanamid to agriculture was discovered only subsequently. Today the largest use of this material is for the fertilization of crops.

[1] "Engineering News," Feb. 7, 1907, p. 150
[2] "Engineering News," Nov. 4, 1909, p. 500.
[3] "Engineering News," Oct. 3, 1912, p. 633.

The discovery of the process for the fixation of atmospheric nitrogen as cyanamid occurred in 1898. Commercial production began in 1906 at Piano d'Orta, Italy, the first year's output amounting to 400 metric tons. Since that time, factories have sprung up in nearly all the important countries of the world. The present factories, with their annual production, are shown in the following table:

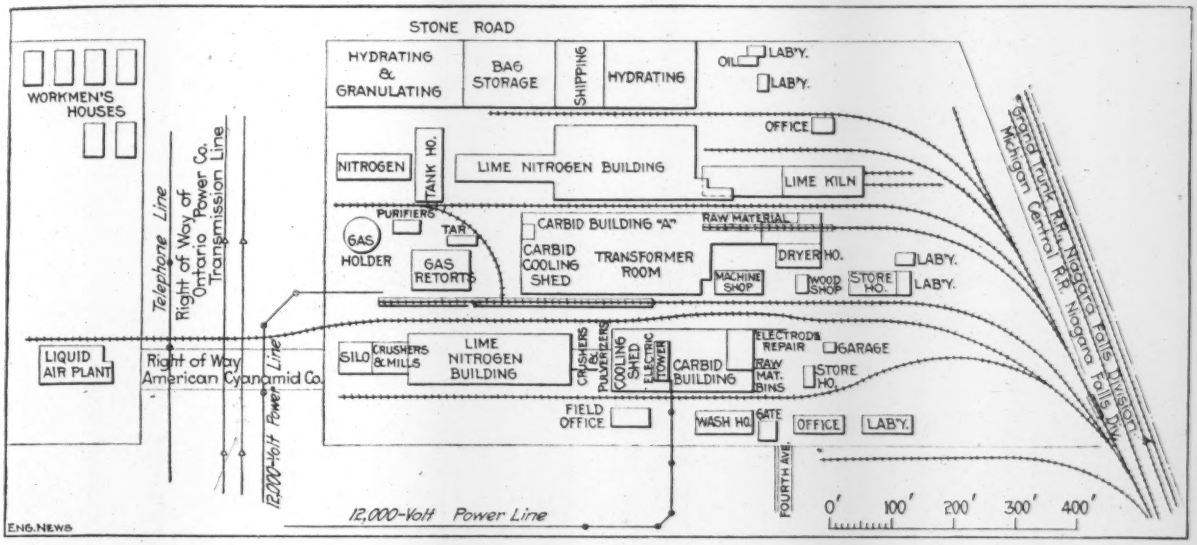


FIG. 2. LAYOUT OF NIAGARA FALLS CYANAMID WORKS

CYANAMID FACTORIES

Name of Company	Place of Installation	Output in Metric Tons per Year
Nitrogen Fertilizers, Ltd. (North Western Cyanamide Co.)	Odda, Norway	72,000
Nitrogen Fertilizers, Ltd. (North Western Cyanamide Co.)	Alby, Sweden	16,000
Societa Italiana di Prodotti Azotate	Piano d'Orta, Italy	6,000
Societa Italiana per il Carburo de Calcio	Terni, Italy	25,000
Societa Piemontese per il Carburo de Calcio	San Marcel, Italy	3,000
Societa Francaise pour les Produits Azotes	Martigny, Switzerland	12,000
	Notre Dame de Briancon, France	7,500
Bayerische Stickstoffwerke	Trostberg, Bavaria	25,000
Ostdeutsche Kalkstickstoffwerke u. Chemische Fabriken	Bromberg, Prussia	....
Mitteldeutsche Kalkstickstoffwerke	Gross-Kayne, Germany	6,000
A. G. fur Stickstoffdunger	Knapsack, Germany	20,000
Societa per l'Utilizzazione delle Forze Idrauliche della Delmazia	Selenico, Dalmatia	6,000
	Dugria', near Almissa	15,000
Japanese Nitrogen Products Co.	Kagami, near Kumamoto, Japan	16,000
American Cyanamid Co.	Niagara Falls, Ont.	*64,000
Societa Anonyme Lonza (Factory erected, but not yet in operation)	Lonza, Switzerland	15,000
Total metric tons, equal to 333,500 U. S. tons.		302,600

*U. S. tons.

USES FOR CYANAMID—Practically the entire American production of cyanamid is used in the manufacture of mixed or complete commercial fertilizers as one of the sources of nitrogen (ammonia). This use is recommended by the makers instead of its use alone, as is the European practice. When used in accordance with the recommendations of the American manufacturers, besides supplying nitrogen to the mixture, it improves the mechanical condition of the mixed goods, neutralizes their free acids and reacts favorably with the acid phosphate used. Cyanamid is a synthetic organic compound and replaces successfully a large part of the more expensive and older forms of organic materials used in commercial fertilizers. This is of particular significance, owing to the scarcity and high price of the animal and vegetable materials heretofore so universally used in fertilizers and the fact that most of such materials have a greater value for other purposes.[1] While cyanamid has other uses than for fertilizers, as noted later, no large part of the American product has been diverted to these fields as yet, for the fertilizer market has absorbed the entire output.

The fertilizer field is by no means the only one in which cyanamid can successfully compete. Thus far, it is true that nearly all the cyanamid manufactured, both in this country and abroad, has been consumed by agriculture. This has been due to the fact that cyanamid needs little preparation for such use and the market was ready. The efforts of the manufacturers have, therefore, been directed toward cheapening the manufacturing processes and enlarging the capacity of their factories.

The significance to the chemical industries of having at hand an abundant source of cheap nitrogen has hardly been realized. Cyanamid is a stable synthetic organic compound of carbon and nitrogen and is capable of easy transformation to an almost endless series of derivatives.

By heating cyanamid with steam, under pressure, practically all the nitrogen in it is set free as a pure ammonia gas. This may be converted into anhydrous or liquid ammonia to be used in refrigeration; or the ammonia gas may be combined with acids forming such salts as ammonium sulphate, phosphate, nitrate or chloride. These all have wide application in the arts. The ammonia gas may also be converted to nitric acid. Ammonia gas, when mixed with air in proper proportions, and passed over a proper catalyzer, is converted to nitric oxide, which, in turn, is easily changed to nitric acid. Large quantities of this acid are consumed in various chemical industries, particularly in the manufacture of explosives.

[1] The earlier studies of cyanamid fertilizers were made with what are now known to be excessive quantities; normal quantities, however, have been found to produce results equal to those obtained with other high-grade sources of nitrogen.

By treating cyanamid with acids under certain conditions, urea can be derived. This is an organic compound used in many chemical processes. By heating cyanamid with water at 100° C. and extracting, dicyandiamid can be obtained for the dye industry.

When cyanamid is heated to redness in the presence of fusible salts, such as sodium chloride or sodium carbonate, the nitrogen presen. goes over to sodium cyanide. This material has a large use, particularly in the extraction of precious metals. Case hardeners for iron and steel can also be made simply and cheaply from cyanamid. By purification of the waste nitrogen gas from the nitrifying ovens in the cyanamid works, argon gas can be obtained. This is a particularly inert gas which occurs in small quantities in the atmosphere and is used for filling high-power tungsten-filament lamps.

All of the above are first-stage derivatives requiring only comparatively simple operations for their production. The researches now under way and completed have only made a beginning in this field. To the organic chemist, cyanamid offers almost unlimited possibilities. It may be combined, for instance, with alcohols, aldehydes or almost any organic group. The facts of predominating interest are, first, that cyanamid is the cheapest known source of organic nitrogen, and, second, that it can be successfully be applied to a great variety of uses.

The Niagara Falls Works—The American company was reported, soon after its formation, to be building a plant in Alabama. This work was never carried forward, as legislation to permit the hydro-electric development on which it was dependent was blocked in Congress by an ultra-conservation element. This development was designed to make the Coosa River navigable, while at the same time water power was to be developed for the cyanamid and other energy-absorbing industries. Therefore, the first American plant was built at Niagara Falls, Canada, in 1909. This was intended to be only a trial plant, to develop the most advantageous operating conditions, although cyanamid was produced commercially at the rate of 12,000 tons per annum.

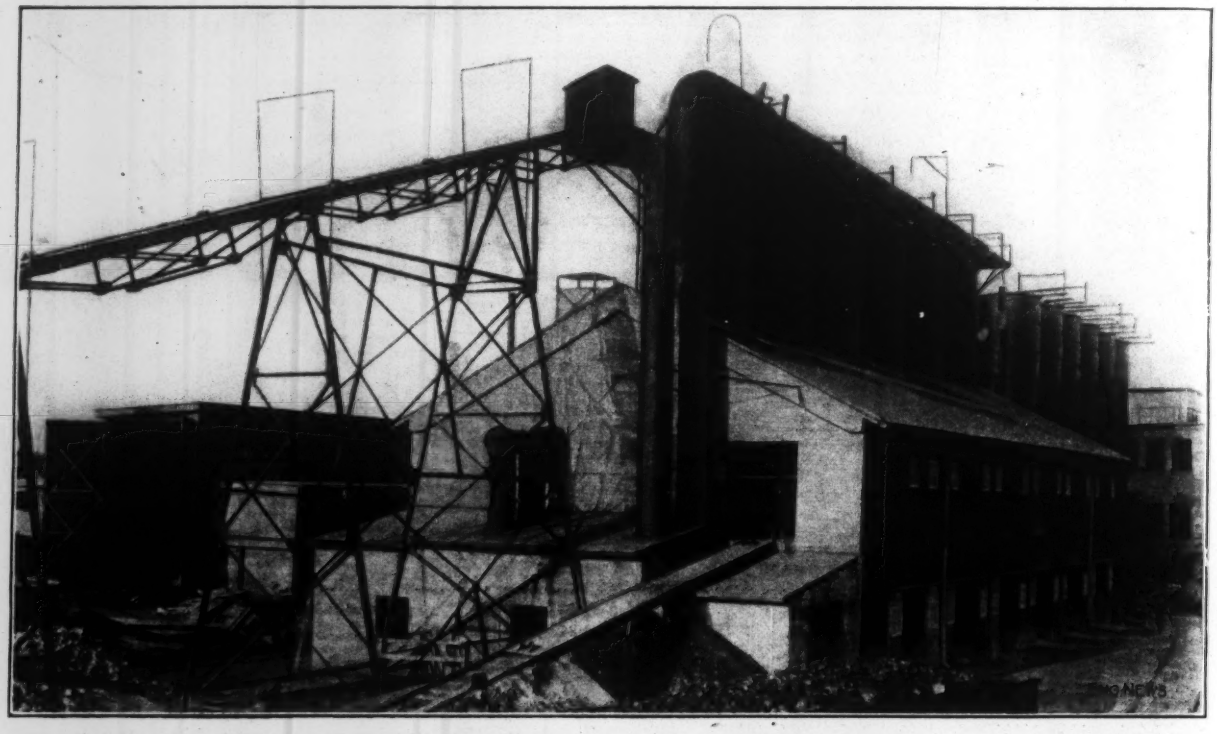


Fig. 3. Lime Kilns of American Cyanamid Co.
(Continuous coal-fired induced-draft type of the Improved Equipment Co., New York.)

The European manufacturing process cannot be satisfactorily followed in detail here because of the higher American labor cost, and hence because of the necessity of more highly developed labor-saving devices. The first enlargement of this original plant was completed early in 1913, bringing the annual capacity to 32,000 tons. A second extension to the works, along new lines, was put into service some months ago, bringing the total capacity of the factory to 64,000 tons of cyanamid per annum.

Lime Kilns and Carbide Plant—The carbide used in the process is all made at the Niagara Falls works. The lime necessary in the manufacture of this carbide is also burned there. The lime plant consists of 12 of the latest type of continuous coal-fired (Doherty-Eldred) kilns, with induced draft. The limestone is brought in on railroad cars and reloaded mechanically to 2-yd. charging cars, which are then pulled up on a cable railway to the charging platform at the top of the stacks. The waste gas is drawn by an exhauster from the top of the stacks. Part of this gas (CO_2) is fed under the fireboxes with a certain proportion of fresh air, thus reducing the temperature of the flame to a proper burning heat; the rest of the exhaust goes to a waste stack.

In making carbide, lime, crushed to 1½- to 2½-in. size, and the proper proportion of coke, crushed to about ½-in. size, are mixed and fed continuously into three-

3-phase electric furnaces. These are open-top refractory hearths, about 6x10 ft. in horizontal section, into which three large carbon electrodes dip and from which the molten carbide is tapped off, from time to time, into cast-iron cooling molds or tapping cars.

In the first and second carbide plants, the carbide furnaces were raised some 3 ft. above the platform from which the furnaces were charged, and this platform in turn was about 3 ft. above the tapping floor. This arrangement followed the European design and was at first thought necessary to protect the operators from the great heat of the 3000-hp. open furnaces. In the latest plant, great improvements in commercial production were secured by an improved design of the furnaces and their appurtenances. The new building (Fig. 4) has, down the center, a wide mezzanine floor which in part covers a transformer room, and acts also in part as a charging platform around the furnaces and extends over the industrial tracks below the furnaces on which the tapping cars run. This puts the top of the furnaces on a level with the charging floor, making charging more easy for the furnacemen; protection from the heat of the furnaces is afforded them by screens or other suitable devices.

This platform arrangement also permits placing the transformers for each furnace close to the furnace, with a minimum length of secondary (low-voltage) conductor. A central tower, extending through the roof of the building, gives a safe entrance for the 12,000-volt supply lines, and space for the necessary protective apparatus, circuit-breakers and switchboards. The first plant has two 20-ton (per day) furnaces, and the first extension two more. There are four 20-ton furnaces of the new type in the last extension.

At the end of the carbide buildings are elevated storage bins for lime and coke, the raw materials. These materials are weighed out, in predetermined ratios, into hopper charging cars, and these cars moved on industrial tracks on the mezzanine level to the furnaces. The carbon electrodes, clamped in water-cooled holders attached to the secondary conductors, are suspended in the furnace from chain blocks carried on overhead trolleys. These electrodes, each carrying approximately 16,000 amp., are raised and lowered by motor-operated hoists. Automatic regulators controlled by the current input to the furnace cause the motor-operated hoists to raise or lower the electrodes, as the case may be, thus automatically keeping the current in the furnace constant at the desired value. As the electrodes are burned away, or as the resistance of the furnace charge varies, the electrodes are automatically moved to suit, thus holding the load constant.

At the far end of the carbide buildings are cooling sheds in which the tapping cars are placed while the carbide cools. When cooled, these cars are moved by small storage-battery locomotives to the crushers. In the new plant, these crushers and pulverizers reduce the full-size carbide pigs to flour without rehandling.

NITRIFYING PLANT—The carbide, approximately 85% pure CaC_2, is cooled, crushed and ground to a fine powder, and in this shape is packed into large perforated steel cylinders for introduction into the electric nitrifying ovens. These are in a building beyond the pulverizer room; here also are elevated bins for the storage of pulverized carbide, devices for charging this carbide into the nitrifying cylinders, cranes for handling these cylinders to and from the nitrifying ovens, and transformers for furnishing the necessary low-voltage current to these ovens.

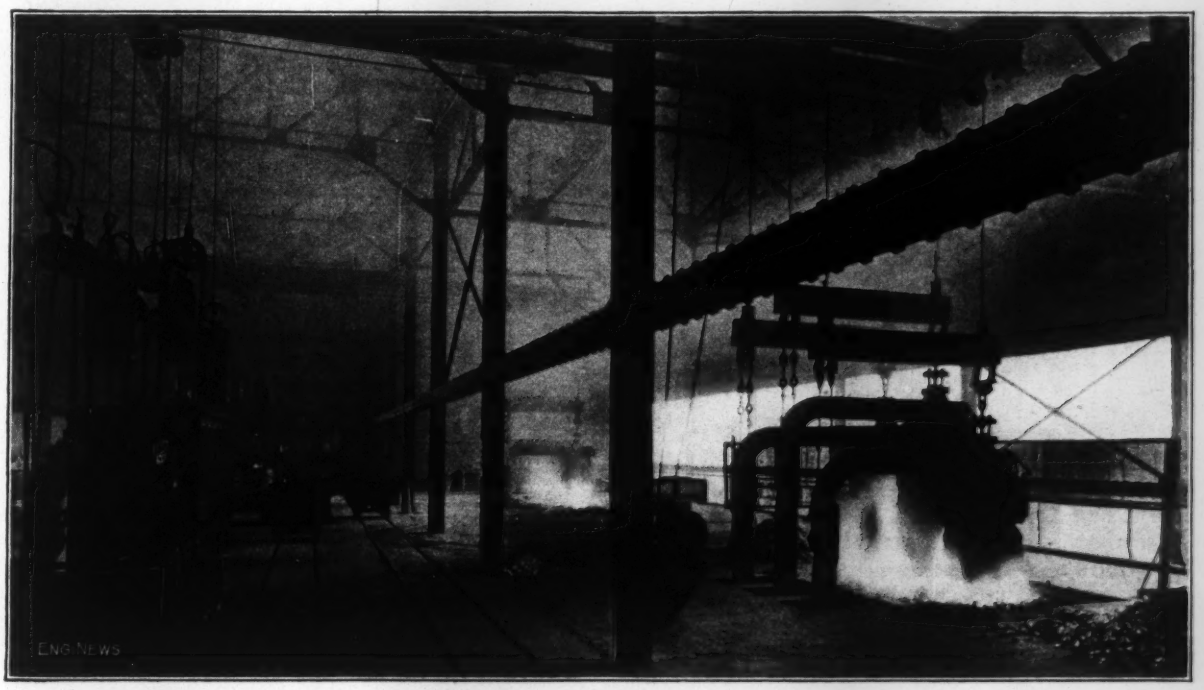


FIG. 4. NEW CARBIDE-FURNACE ROOM

Each cylinder is set down by an overhead crane into a brick insulated oven but little larger than the cylinder, and the oven closed with a cast-iron lid. A small carbon electrode is then run into the interior of the oven through a gland in the lid, completing the electric heating circuit

through the steel cylinder. Enough current is passed through this electrode to raise the temperature of the oven charge to approximately 1200° C., and nitrogen gas under pressure is led through ducts into the oven. A chemical reaction then takes place between the carbide and the nitrogen, according to the formula $CaC_2 + 2N = CaCN_2 + C$. After this fixing of nitrogen gas by the carbide is well under way, the exothermic reaction furnishes sufficient heat to hold the mass at the reacting temperature until the conversion from carbide to cyanamid is largely completed. As it is not economical to carry the process to the last stage of completion, the remaining unconverted carbide is reduced to lime by the addition of water after the cyanamid has been removed from the oven, cooled, crushed and pulverized. The cyanamid as it comes from the ovens is a blue-black agglomerated mass, largely crystalline.

per day, and comprising seven benches of six section silica retorts. These benches are run very hot to produ a gas rich in hydrogen and a coke low in volatiles. Th coke made in this gas plant forms part of the coke su ply necessary for carbide manufacture.

To supply nitrogen gas for the recent extension, Claude liquid-air plant has been erected at the far end the works. This separates the nitrogen from the oxyge by the fractional distillation of liquid air. The air in takes have been run out north and south of the plant fo several thousand feet, air being drawn through one o the other according to the direction of the wind. In this way, fresh pure air is always secured, avoiding takin in any traces of acetylene or other combustible gas with the intake air. (Any acetylene gas which might be mixed with the air fed to the apparatus would liquefy easily in the liquid-air machines, and accumulate as a

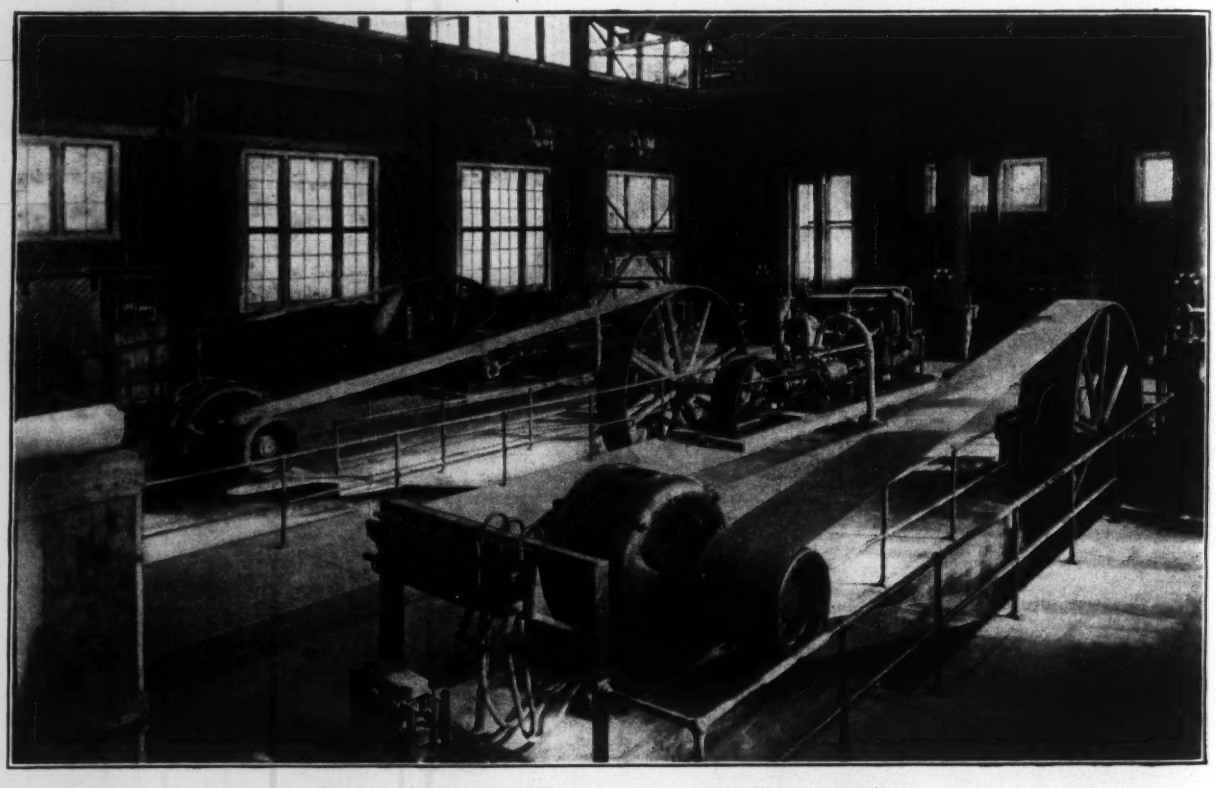


FIG. 5. LIQUID-AIR PLANT; AMERICAN CYANAMID CO.

NITROGEN SEPARATION PLANT—In the older plant, nitrogen gas is separated from the oxygen of the air by the so called copper process, which consists of passing the air over red-hot copper. Finely divided copper is molded into porous briquettes with an inert cementing filler. These briquettes are packed into steel retorts, each externally heated by a gas furnace. As air is forced through these retorts, its oxygen combines with the copper. When the copper has been well oxidized, the flow of air is diverted to another series of retorts. Coal gas is then passed through the first series, which are at a high temperature, and the copper oxide is thus reduced to the metallic form again, with the production of carbon dioxide and water vapor. For the manufacture of the coal gas for this reduction of copper, a complete gas plant was built, having a capacity of half a million cubic feet

solid in the reservoir of "boiling" liquid oxygen. While elaborate precautions are taken to avoid this accumulation, yet if these should all fail at the same time, an explosion might result. Hence, the precaution of securing air free of traces of acetylene.)

The machinery for this liquid-air plant was all imported (except the driving motors) and was erected and tested by the makers. Air, after being freed of carbon dioxide, is compressed in three-stage water-cooled tandem compressors, being delivered at 500 lb. per sq.in. pressure and room temperature. It is then dried, and expanded in multiple-effect apparatus, the incoming high-pressure supplies being cooled by the expanding air and thus become colder and colder until the expanded air reaches the most economical critical point of temperature and pressure, when the air liquefies and is drained to the fraction-

ating towers. The liquid air is warmed by the compressed air going to the multiple-effect orifices and the nitrogen is distilled off at a temperature of about 195° C. below zero. This nitrogen, on leaving the towers, is at room temperature and is practically chemically pure; it is then led to the nitrifying ovens. For the present the liquid oxygen, bearing some liquid nitrogen, is discarded. A reserve storage of about 100,000 cu.ft. (on a basis of standard temperature and pressure) of nitrogen gas is carried in steel storage bottles under a pressure of about 1600 lb. per sq.in., these bottles being charged as required by a small water-cooled water-lubricated compressor.

Beyond the ovens themselves, which are in the center of the nitrifying building, is a space for cooling the cyanamid after its removal from the ovens, and beyond this space is another group of crushers and pulverizers. After pulverization, the cyanamid is stored in reinforced-concrete bins, each bin having a capacity of 500 tons.

GENERAL OPERATION—It is interesting to trace the progress of materials through the works to connect up the several stages of the process above outlined. Limestone is brought in gondola cars, over the Michigan Central and Grand Trunk railway approaches on the east, to the lime kilns. The burned lime, after cooling, passes in an underground conveyor to the raw-material building of the old plant, where it is elevated. Part is deposited here in the storage bins of the old carbide plant and part is carried on an overhead conveyor to the storage bins of the new carbide plant. The coke purchased is similarly brought in from the east and passed through crushers and driers; quenched coke from the gas plant is also brought back in cars to the crushers and driers and is added to that purchased. After drying, the coke is elevated to a conveyor on the same structure carrying the lime conveyor, and is disposed of to the two plants as was explained for the lime. Lime and coke are distributed to the furnaces in small charges, as already noted.

The materials then pass through the carbide and cyanamid processes, undergoing the changes previously described. Pulverized cyanamid is transferred from the concrete storage bins by a long screw conveyor to a hydrating building where special machines, similar to lime hydrators, mix with it the proper amount of water to reduce any free carbide and hydrate the free caustic lime to lime hydrate. This hydrated cyanamid is then stored in bulk to cure and is later packed in burlap bags for shipment. From this same building, shipments to purchasers are made. The material is sold entirely on its nitrogen content as determined for each shipment by the chemical analysis of a representative sample.

While a description of the process and the chemical reactions employed seem simple, yet the industry is one of those which can be conducted successfully only by the strictest scientific supervision. Being new, the industry has been forced to develop its own specialists. Every operation of the process is under chemical control. A large laboratory is maintained for research and routine analyses and a force of chemists and engineers is constantly employed. The whole manufacturing problem is conducted as an engineering operation.

Since, for reasons previously explained, the industry could not be located in the center of the fertilizer-consuming district of the United States, it was placed at Niagara Falls, where a large supply of electric power was available. While the cost of such power is of importance, it will be evident from the foregoing outline of the processes employed that the cost of power is not the predominating factor, as evidently it is in the arc process or as is popularly supposed to be the case in all electro-chemical industries. Of equal importance are cost of labor, raw materials, overhead charges and freight to the market centers.

The present factory at Niagara Falls, Canada, occupies a plot of ground 40 acres in extent and represents an investment of over $3,000,000 for buildings and equipment alone. The buildings, erected by Westinghouse Church Kerr & Co., are of substantial steel and concrete construction, with about 12 acres floor space. The layout includes a complete private water supply for plant uses and fire protection, bath and change house for the operatives, first-aid hospital and cottages for workmen. As the processes are inherently continuous, the operations continue 24 hr. per day and 365 days per year, on eight-hour shifts. Normally, about 750 men are employed and approximately 30,000 hp. electrical energy is continuously used. The freight movement in and out of the plant totals about 215,000 tons per year, while the sales value of the cyanamid produced approximates $2,750,000 per year.

The officers and employees of the company directly connected with the construction and operation of the plant are as follows: Frank S. Washburn, President; K. F. Cooper, General Manager; A. E. Bonn, Sales Manager; G. E. Cox, Works Manager; H. P. Eastman, Superintendent; W. S. Landis, Chief Technologist.

The Philadelphia Ruling on the design of flat slabs of reinforced concrete has recently been promulgated by **Edwin Clark, Chief of Bureau of Building Inspection of the City.**

METHOD OF FIGURING FLAT-SLAB CONSTRUCTION

Drop Construction

L = C. to c. of columns of the longest of straight bands in in.

L_1 = Edge to edge of capital head in in.

w = Total dead and live load per sq.ft.

d = Distance in in. from center of gravity of centroid to center of steel at the drop.

d_1 = Distance in in. from center of gravity of centroid to center of steel at the center of slab.

If drop construction is not used, $d = d_1$.

Sufficient depth of slab to be provided for shearing stresses as well as bending stresses.

Capital head = not less than $\frac{1}{10}$ L.

Width of drop = $^{38}/_{100}$ L.

Width of bands = $\frac{1}{10}$ L.

$-M$ = Moment at edge of capital head.

$+M$ = Moment at center of span.

$$\text{Load carried by straight band} = \frac{\text{total bay} - \text{capital head}}{2} \times w$$

$$-M = \frac{\text{total bay} - \text{capital head}}{2} \times \frac{wL_1}{12}$$

$$+M = \frac{\text{total bay} - \text{capital head}}{2} \times \frac{wL_1}{24}$$

Width of concrete to resist compression at edge of capital head = Width of drop.

Width of concrete to resist compression when negative moment = $-\frac{wL_1}{24}$ = width of band + 3 T (T = thickness of slab).

Width of concrete to resist compression in center of span = Width of band + 6 T.

Steel:
$$\frac{-M}{d \times 16{,}000} = x$$

Place 66% of x in straight band
Place 43% of x in diagonal band } over capital head.

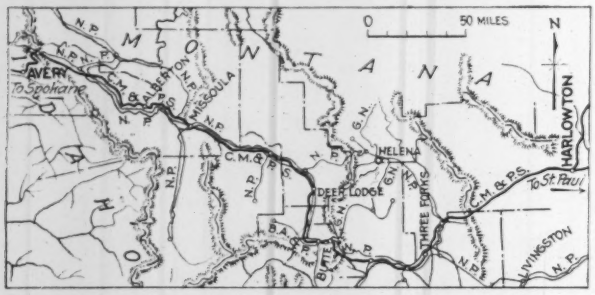
$$\frac{+M}{d_1 \times 16{,}000} = x_1$$

Place 66% of x_1 in straight band
Place 43% of x_1 in diagonal band } in center.

For 2-way reinforcement over capital head the amount of steel in straight band = x.

Electric Traction on the Chicago, Milwaukee & St. Paul Ry.*

The plans for the substitution of electric traction for steam on certain mountain divisions of the Puget Sound line of the Chicago, Milwaukee & St. Paul Ry. have been completed and contracts let as has been previously announced in these columns.† The initial change is on two



Rocky Mountain Divisions of the Chicago, Milwaukee & St. Paul Ry.

engine divisions comprising 113 miles of main line between Three Forks and Deer Lodge, Mont.; this is the first step toward a pending change on two more engine divisions which will extend the system from Harlowton, Mont., to Avery, Idaho, some 440 miles of line with a total of 650 miles of track. Besides this it is expected that, if the operating results of the initial installation are as satisfactory as anticipated, the system will be extended to the Pacific Coast, giving 850 miles of line. The change, from the start, will require the exchange of locomotives only at points where steam units would ordinarily be shifted, so that there will be no useless duplication of equipment or loss of efficient operation through short runs, etc. It is reported that the change is made by the officials of this road purely on economic grounds and in hope of such superior operating results as to return an attractive profit on the investment required.

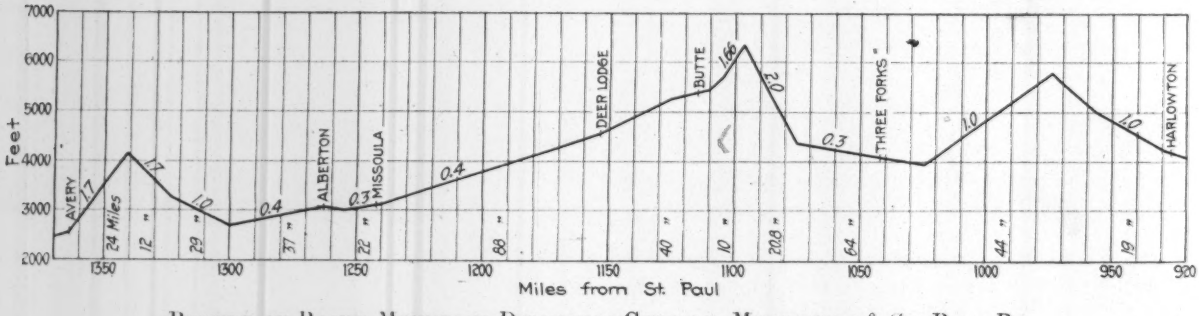
Power Supply

The railroad will not generate its own electric current; it has contracted with the Montana Power Co. for an adequate supply. This company has a transmission network connecting a number of hydraulic plants and one steam station, and it has plans for several more developments. A price of 0.536c. per kw.-hr. is given the railway, but based on 60% load factor. Such a high utilization of capacity can be secured by adjusting train schedules.

The first 113 miles equipped will have four substations with step-down transformers and motor-generator sets converting from 100,000 volts, 60-cycle three-phase, to 3000 volts direct current. This is the first use of such high-potential direct current, exceeding by 600 volts the somewhat similar installation on the near-by Butte, Anaconda & Pacific Ry. (see Engineering News, Aug. 17, 1912; June 26, 1913; Mar. 19, Apr. 2 and June 25, 1914). Each motor-generator set will have a 2300-volt synchronous motor, two 1500-volt direct-current generators (connected permanently in series) and a single exciter on the same shaft supplying the fields of all three machines. To insure good commutation at overloads, the generators have commutating poles and compensating pole-face windings. The motors will be used super-excited at heavy loads so as to draw "leading current" and regulate the transmission-line voltage better.

The substations are from 27 to 42 miles apart. In addition to the transmission lines of the power company, a tie line will be run by the railway company from the first to the fourth station largely along the right-of-way. This will result in each substation being fed with power from two directions to reduce the probability of interruption. The stations at each end of the line will have two 2000-kw. units. The two in the middle will have three 1500-kw. units.

For the distribution of current to locomotives, an overhead trolley will be used. Two No. 0000 wires will be suspended, parallel and in the same horizontal plane, from a steel catenary supported on wooden poles by brackets, wherever track alignment permits, and by cross-spans on sharper curves and in yards. Steel poles will be used only where the spans are so long as to exceed the possibilities of wood construction. The hangers from the messenger cable will connect alternately to one and the other of the two parallel No. 0000 wires. It has been found by experiment that this gives additional flexibility and permits collection, without sparking, of very heavy currents at low speeds or moderate currents at very high speed, and is thus adapted to both heavy grades and high-speed stretches of the line.



Profile of Rocky Mountain Divisions; Chicago, Milwaukee & St. Paul Ry.

Locomotives

At first, there will be nine freight and three passenger locomotives, each weighing approximately 260 tons and similar in all respects except that the gear ratio of the passenger locomotives will permit of the operation of 800-ton trains at 60 miles per hour, and will carry an oil-fired steam boiler for heating the cars. All electrical and me-

*From information supplied by the General Electric Co., Schenectady, N. Y.

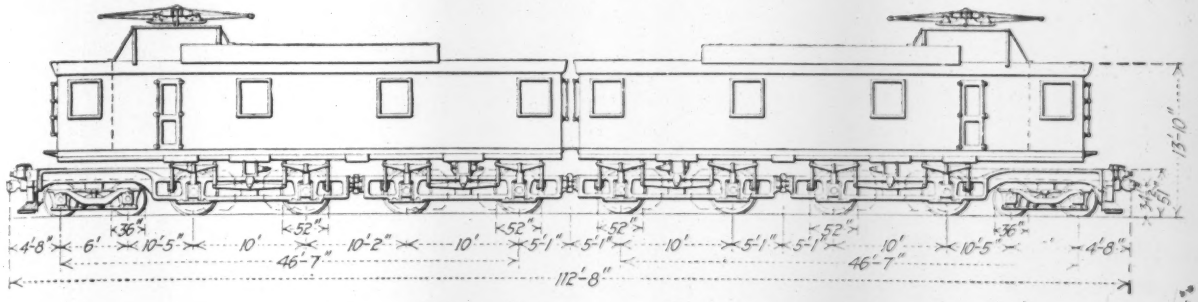
†"Engineering News," Jan. 16 and Dec. 25, 1913, pp. 132 and 1331; Feb. 12, 1914, p. 371.

chanical parts of the two types of locomotives will be interchangeable to reduce cost of operation and maintenance.

The main frame, which will carry all the traction and buffer stresses of the locomotive, is in four parts, articulated. The two end sections carry extensions which hold the small leading trucks. There is 30 tons weight on each guide truck. The cab is divided into two similar sections; at the outer end of each is a compartment for the engineman, the remainder being occupied by control equipment, train heater, air-brake apparatus, etc. Owing to the unmately 220 miles length, changing crews, however, at the present division points. This will be possible since the electric locomotives will need inspection only after a run of some 2000 miles and require no stops for taking on coal or water, or for cleaning.

Organization

This work on the Chicago, Milwaukee & St. Paul is under the direction of C. A. Goodnow, Assistant to the President, and in charge of construction. The field work is under the supervision of R. Beeuwkes, Electrical Engineer of the railway. Contracts for the electrical equipment have been placed with the General Electric Co., of Schenectady.



Direct-Current Locomotive; Chicago, Milwaukee & St. Paul Ry.

usual height of trolley wires (25 ft. above rail), the pantograph bases have to be elevated about 5 ft. above the cab roof.

Each driving axle is twin-geared to a 1500-volt motor rated to give 430 hp. for one hour, or 375 hp. continuously. The locomotive thus has a one-hour rating of 3440 hp., and a continuous rating of 3000 hp., which makes it the most powerful type yet developed. The drawbar pull at starting approximates 120,000 lb., with 30% coefficient of adhesion. The motors are connected two in series permanently, the four groups being handled in the usual series and parallel combinations. The motors have commutating poles and openings for forced ventilation which is supplied by a motor-driven blower in the cab.

The freight locomotives are designed to haul a 2500-ton trailing load at 16 miles per hour on gradients up to 1%. The same trainload will be carried unbroken over the 1.66% and 2% ruling grades on the west and east slopes of the Rocky Mountain Divide by the help of a second locomotive acting as pusher.

One of the most interesting parts of the locomotive equipment is the control which is arranged for regenerative electric braking on down grade. This scheme has not before been employed with such motors and on such a scale. Track provision is being made at Donald, the summit of the Rocky Mountain grade, so that the pusher locomotive may run around the train to the head; then the entire train on the down grade will be under compression and held back by the two locomotives under the control of the engineman in the leading unit. It is expected that the locomotives will develop sufficient regenerative-braking capacity to hold back the entire train to proper speed on down grade without use of the air brakes, which then may be needed only in emergency and for stopping the train. This, besides giving a duplicate braking system and greater safety of operation, should reduce breakdowns, wheel and track wear, maintenance costs, etc.

When the entire line of four engine divisions is converted from steam to electric traction, it is proposed to combine them into two locomotive divisions of approxi-

Fire Protection for the Panama-Pacific Fair Buildings

The central fire- and police-alarm system for protecting the buildings of the Panama-Pacific International Exposition at San Francisco has been installed in part. The system comprises a central office and full automatic equipment consisting of a 12-circuit switchboard, an 8-circuit automatic repeater with four local engine-house circuits, a signal-wheel transmitter for transmitting still and special alarms, a punching register, take-up reels and an automatic time stamp for recording the exact time when an alarm comes in. The stamp is controlled by a self-winding electric clock. All testing of lines and batteries and the battery charging are controlled from the main switchboard.

The fire-protection system is described by the official organ of the American Society for Fire Prevention as follows:

There are 102 fire-alarm boxes installed throughout the grounds and buildings. These boxes are absolutely noninterfering and successive, and so constructed that nine boxes may be pulled simultaneously and all of them will register in succession their respective signals.

Each of the three engine houses on the grounds is equipped with an ornamental pressed-steel panel on which are mounted a 12-inch electro-mechanical gong, punch register, tapper bell, take-up reel and an automatic switch which turns on the lights in the engine house on the first stroke of the alarm; these lights are automatically turned off by the switch at a predetermined time after the fire apparatus has left the house.

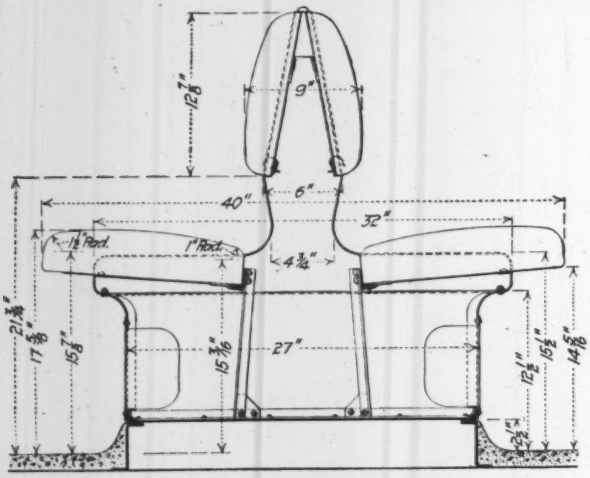
z There is a similar set of apparatus in the headquarters of the Exposition military guards in the Service Building.

There will be 102, seven-call combination police telephone and signal boxes. These, together with the fire-alarm boxes, are mounted on ornamental iron pedestals, surmounted by a red globe on which is etched "Fire Alarm" in white letters. By means of a signal-wheel transmitter, operated by an electric motor in the central office, code signals will be flashed on these lamps at night to notify the guards that their services are required.

Field and Office

Scientifically Designed Car Seats

In the design of seats for the new steel subway cars of the New York Municipal Ry., the coöperation was secured of the American Posture League, an organization of orthopedic experts. The type finally evolved is consistent with the League's recommendations and practical operating necessities. The accompanying illustration shows a section through one of the transverse seats. The passenger sits firmly and comfortably in correct upright posture; incorrect position cannot be held without constant effort. Neither heads nor hats will bump with passengers sitting back to back. Seats and back cushions, except for folding seats, are spring upholstered, covered with woven rattan stretched over hair felt inclosed in canvas. The folding seats have no springs but are heavily padded with hair felt. Frames, cushions and backs are being made by Hale & Kilburn Co., Philadelphia.

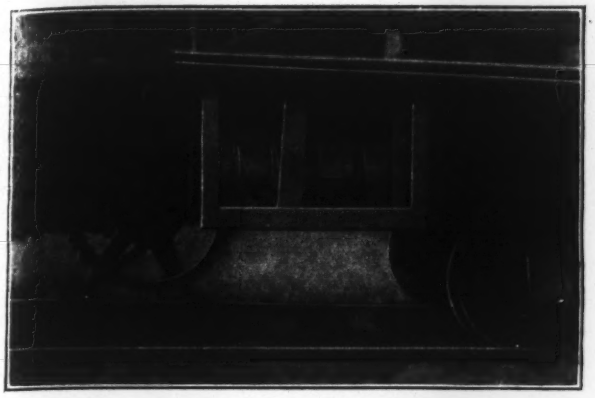


Cross-Section of Seat in New Subway Car; New York Municipal Ry.

Individual Electric Lighting Outfits for Steam Shovels

Small generating units have been placed on several of the steam shovels of the Utah Copper Co., because of troubles with other means of supply. These machines have to operate on night shift and good illumination is required on the bank excavated and around the shovels. A general illumination of the work is furnished by searchlights on the opposite side of Bingham cañon. This is supplemented with some 20 incandescent lamps at each shovel. For some years a cable and reel was used connecting to a pole line, but rocks rolling from one terrace to another carried away poles and injured the cables. Trial was made of a small (1-kw.) steam-turbine set recommended by the Westinghouse Electric & Manufacturing Co.; this was mounted on the under side of the main frame of one shovel (see accompanying illustration) and supplied with steam from the shovel boiler. This shovel made such a good record that six more outfits were installed. The unit is designed for running long periods

Interior of Subway Car with Correct-Posture Seats



SMALL TURBINE-GENERATOR UNIT FOR STEAM SHOVELS

without care. There are no delicate parts; the governor allows full capacity to be developed on from 90- to 250-lb. steam pressure, so that steady light is secured in spite of abrupt changes in steam pressure.

Computing Machines in Engineering

By P. H. Skinner.*

The economy of the computing machine is due not only to its extreme rapidity but also to the fact that, by eliminating logarithms and otherwise simplifying the work, it enables a less highly trained and therefore less highly paid man to perform the work. Thus it saves money in two ways: By reducing the time necessary for computation, and by reducing the money cost of the remaining time. The work must, of course, be supervised by a competent computer.

To be of use to the engineer, a machine must be accurate, rapid, simple in operation, and durable, and its initial cost must not be too high. During the last ten years, the writer has tested eleven different types of machines in various kinds of work, having performed computations for several branches of the government of the District of Columbia, for private individuals, and in research work. As he has used the "Brunsviga Midget" for several years, this machine will be taken to illustrate the application of machine work to engineering computation. It differs from several others of similar make mainly in its greatly reduced size and weight—covering an area of 12.7 × 6.3 in. (two-thirds the area covered by an open volume of Vega's Logarithms) and weighing 7½ lb.—thus being moved easily from place to place, and resting on the drawing or map with little interference with the work.

This type of machine consists essentially of a fixed counter—the multiplicand counter—and a sliding carriage containing a multiplier or quotient counter and a result counter. The machines are made in different capacities, but all ordinary engineering work can be performed upon the smallest size—that with 9 places in the multiplicand, 8 places in the multiplier, and 13 places in the result.

*Chief Computer, Surveyor's office, Washington, D. C.

Features of the Computing Machine

Accuracy—A number once set upon the machine cannot be altered until the operation has been finished, so that the operation indicated upon the machine is the operation that has been performed. It is impossible for the machine to give an incorrect result except by breaking down completely.

Rapidity—*Multiplication*: Tests made by the writer seven years ago show that the machine is about six times as rapid in multiplication as hand work.

Division—Similar tests show the machine to be about seven times as rapid as hand work, requiring also much less time in checking.

Addition—In this operation the machine is somewhat superior to hand work, but no check is available except repetition of the work.

Subtraction—Where one number is to be subtracted from a number of others, the machine is more rapid than hand work, but for single subtractions hand work is best.

Square Root—The following is easily worked out in 35 seconds:

$$\sqrt{176.92^2 + 348.57^2} = 390.90$$

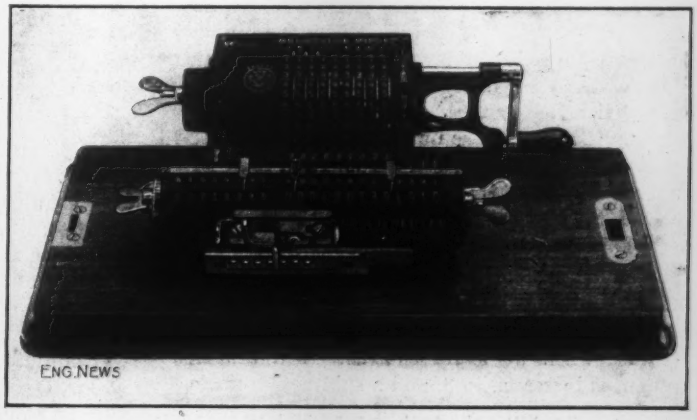
Simplicity in Operation—Any clerical worker can learn to operate the machine for all ordinary work with a day's practice, and for all operations within a week.

Durability—A machine in constant use in the office of the Surveyor of the District of Columbia for 4 years is apparently in as good condition as ever, and no repairs have been made upon it.

Initial Cost—Machines available for use of engineers range in price from $250 to $450. The "Brunsviga Midget" sells for $275.

Operation

Multiplication—One factor being set upon the multiplicand counter, the other is made to appear upon the multiplier counter by turning a crank. An average of 2½ turns of the crank is necessary for each figure of the multiplier.



A COMPUTING MACHINE SUITED TO ENGINEERS' USE; THE "BRUNSVIGA MIDGET"

Division—This is merely the reverse of multiplication, but an average of 5 turns of the crank for each figure in the quotient is necessary.

Division and Multiplication—Cases like the following

may be worked out in one operation, but only small numbers can be used

$$^{17}/_{52} \times 36 = 11.77$$

This is accomplished by setting 17 on the extreme left side of the multiplicand and setting 36 on the extreme right, moving the carriage over to its extreme right position, and adding and shifting the decimal place until 52 appears under the 17, when 11.77 will appear under the 36, and 0.3269 (the value of $^{17}/_{52}$) will appear on the multiplier counter.

Addition—The number to be added is set upon the multiplicand counter, when a clockwise turn of the crank will cause that number to be added to that upon the result counter.

Subtraction—The same as addition except that the crank is turned in the counter-clockwise direction. If the number subtracted is greater than that upon the result counter, the operator is notified by the ringing of a gong.

Square Root—First Method—The number whose root is to be found is registered upon the result counter, and pointed off into places of two figures each, as in hand work. The square root of the largest square in the left-hand period is set upon the multiplicand counter and subtracted as many times as there are units in the root. The carriage is shifted one place to the left, and the root upon the multiplicand counter is doubled, and used as a trial divisor. The remainder (including the next period of two figures) is divided mentally by this trial divisor, and the quotient is annexed to the part of the root upon the multiplicand counter, when we subtract a number of times equal to this last quotient. The carriage is shifted another place to the left, the last figure in the part of the root already found is added to this part of the root (on the multiplicand), this is used as a trial divisor, as before, and the number on the multiplicand counter is subtracted as many times as there are units in the quotient. This process is continued until one-half the places in the root have been found, or one more than half if an odd number of places, when the number upon the multiplicand counter is used as an ordinary divisor and the remaining figures of the root are obtained as in division.

Second Method—The number whose root is to be found is registered upon the result counter as in the previous case, unity is subtracted from the right-hand period, then 3, then 5, etc., until the number to be subtracted is greater than the number to be subtracted from. The carriage is then shifted one place to the left, the number on the multiplicand is increased by unity, and 1 is annexed to the next column to the right in the multiplicand counter, when we again subtract, then the right-hand column is increased to 3, and a subtraction made, then 5, etc., as before, until one-half of the required root has been found, or one more than half, as above, when the remaining figures are found as in division.

The advantage of the second method is that no trial divisor is used, and no time is wasted by using a wrong quotient. By both these methods the last figure in the root may show an error of one unit, but this may be obviated by carrying the number out to one more place than the number required. To check the operation, we square the root found, and compare with the original number.

Application to Engineering Work

Traverse—The course having been set upon the multiplicand counter, we cause the sine and cosine of the bearing to appear successively upon the multiplier counter, when the latitude and departure will appear upon the result counter. It is unnecessary to compare the numbers on the machine with the data, as this check takes some time, very few errors are made, and a fairly large proportion of those that are made—such as using the function of a wrong angle, transposed figures, etc.—are not picked up by it. It is best to complete the traverse, when two methods of checking are offered. (1) If the traverse forms part of a tract whose area is known or is to be computed, then adding the areas of the various parts and comparing with the total area affords a very nearly absolute check. (2) If the traverse stands by itself, we may check by dividing the smaller coördinate by the larger and comparing the anti-function with the bearing; the larger coördinate being on the multiplicand counter, we cause the secant or cosecant of the bearing to appear on the multiplier counter, when the course will appear on the result counter. It is evident that this check is much superior to any that can be applied in hand or logarithmic work, since the check is absolute, the functions employed in the check being different from those in the original work.

Adding Angles—Angles may be added on the machine more rapidly and with a greater degree of accuracy than by hand. But as the separate items of such addition are sexagesimal quantities, the result appears on the result counter as an apparently confused expression of degrees, minutes and seconds. The expression may be reduced to the proper form by adding the arithmetical complement of 60 to the second column and to the minute column.

Thus: The multiplicand counter being numbered from right to left, the three left-hand places, 9, 8, and 7, are reserved for degrees, since these are properly expressed in units, tens, and hundreds, and the two places 5 and 4 are reserved for minutes, since these are properly expressed only in units and tens, and similarly places 2 and 1 are reserved for seconds. Places 6 and 3 serve to separate the groups. The items being thus set and added, 9 is set on the multiplicand counter at place 3, and 4 at place 2, this number is added n times to the sum on the result counter until 0 appears in place 3 and less than 6 in place 2. By this means 60 has been subtracted n times from the number shown in the last 3 places (or the number of seconds) and n has been added to the number in place 4 (or the units' place of the minutes column). The same operation performed in places 6 and 5 reduces the minutes to degrees.

Of course, the two columns (seconds and minutes) may be reduced simultaneously.

This operation is correct only when the total sum of the seconds and the total sum of the minutes are each less than 1000; but, as the reduction may be made at any stage of the addition, we have only to watch the result counter, and reduce as described when the sum of either the seconds or the minutes approaches 1000. This operation appears somewhat cumbersome and uncertain from description, but the writer has employed it with success for the last 5 years. The following example will illustrate:

ADDITION OF ANGLES

Place Nos.	9	876	543	21
	°	′	″	
		400	550	45
	1	390	580	20
		570	010	30
		590	480	00
	1	150	120	30
	2	020	200	00
	1	660	590	30
		120	370	30
	1	630	610	00
	9	532	911	85
		9	409	40
	9	542	321	25
		9	409	40
	9	551	730	65
		9	409	40
	9	561	140	05
		9	400	00
	°	′	″	
	9	570	540	05

ADJUSTMENT OF COÖRDINATES—The error of closure and the correct total for each column being determined, this correct total is to be divided by the actual total, an operation requiring about 15 to 20 sec.; this operation gives the proportion by which each coördinate is to be multiplied, which is accomplished by causing each coördinate to appear upon the multiplicand counter, when the adjusted coördinate will appear upon the result counter. The operation is checked by adding the adjusted coordinates and comparing the sum with the corrected total.

DOUBLE MERIDIAN DISTANCES—These are worked out with ease, as any number set upon the multiplicand counter may be either added or subtracted at will according to the direction in which the crank is rotated; and a number once set upon the machine cannot change until the end of the operation.

PARTIAL AREAS—When all the necessary multiplications have been made (without checking during the process) each partial area is divided by one of its factors, when the other will appear upon the result counter if the work is correct. This check, while not mathematically absolute, is practically so, and is superior to the check by casting out 9's.

The various steps in working out a traverse of sixteen courses were recently timed by the writer with the following results, the courses varying in length from 92.10 ft. to 2552.50 ft.: Working out coördinates, 12 min. 45 sec.; checking coördinates (secant check omitted), 9 min. 15 sec.; adding coördinates (using listing machine), 2 min. 15 sec.; adjusting coördinates, 16 min. 30 sec.; determining D. M. D's and partial areas and checking, 23 min. 45 sec.; total, 64 min. 30 sec.

Similarly, a 9-course traverse was worked out (without determining area) in 16 min. 30 sec. (7 min. 10 sec. in working out the coördinates, and 9 min. 20 sec. in checking, including the secant check).

SOLUTION OF TRIANGLES—*Sine Formula*—Divide the known side by the sine of the opposite angle (an operation requiring about 20 sec., exclusive of time spent in looking up the function), set the resulting quotient on the multiplicand counter, and cause the sine of each of the remaining angles to appear on the multiplier counter, when the value of the required sides will appear upon the result counter. These multiplications can be performed in about 5 sec. each (exclusive of time spent in looking up functions). If a direct check is required, perpendiculars may be dropped from one of the vertices to the opposite side.

Three-Side Case—Use the formula

$$\frac{\frac{(a+b)(a-b)}{c}+c}{2b}=\cos A$$

This can be worked out in 1 min. 35 sec.

All other cases of oblique triangles can be more readily solved by combinations of right triangles than by the somewhat cumbersome and involved formulas of logarithmic computation.

It is impossible to mention all the applications of the computing machine to engineering computations, but in general any work that can be done with paper and pencil can be done on the machine with greater rapidity and a higher degree of accuracy. The short method of computing adjacent lots of equal frontage whose rear lines make an oblique angle with the street, as described in ENGINEERING-NEWS, Oct. 8, 1914, may be performed on the machine with considerable saving of time, as the area of each lot is obtained by one turn of the crank, and depths likewise, so that recording the results becomes the greater part of the operation.

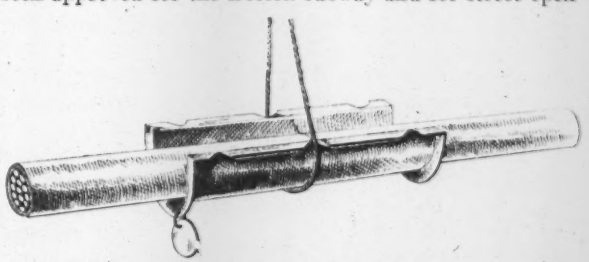
The machine is of considerable help in working out grades: The rate is set on the multiplicand counter, the station (in feet) on the multiplier counter, and the grade of that station on the result counter; then by causing the number of any other station to appear upon the multiplier counter, the grade of that station will appear upon the result counter. Continuing the process until we reach some known station and grade will afford an absolute check.

The Monroe Calculating Machine, which has appeared recently upon the market, is similar to the Brunsviga in operation, except that the quantities are set on the machine by means of keys instead of by levers. It has 16 places in the result counter, 8 in the multiplicand, and 8 in the multiplier.

The writer finds Loomis' Logarithms of service in machine work, as this publication contains, in addition to the logarithms, the natural functions to 6 places of decimals, and 1-min. intervals, with means for interpolation, a feature lacking in most tables of natural functions in use among engineers. The work is published by the American Book Co. and sells for $1.

A Cradle Support for Electric Cables Exposed by Construction Work

The pressed-steel cradle shown in the accompanying illustration is being used to support exposed cables on some of the New York subway excavation and it has also been approved for the Boston subway and for street open-



A STEEL CRADLE FOR SUPPORTING ELECTRIC CABLES DURING EXCAVATION

ings in Baltimore. The old practice has been merely to swing any exposed cables from timber work, etc., by wire or marlin; damage to the cables from chafing, etc., often resulted. The device has been patented by M.

Blumenthal and B. S. Barnard and is being supplied by B. S. Barnard & Co., 50 Church St., New York. For the lines of power and telephone companies, galvanized cradles are recommended; for fire and police cables red and green enameled pieces are put out. Brass tags complete the designation of cables.

Piledriver with Traversing Leads for Driving Trestle Bents

In reconstructing the Coshocton bridge of the Panhandle route of the Pennsylvania Lines West at the Muskingum River crossing in eastern Ohio, the contractor solved some of his trestling problems by building and successfully using a quite original piledriver rig.

The work to be done was to drive a falsework trestle for the erection of the new steel truss bridge (three 240-ft. spans) alongside of the old bridge which had been damaged in the flood of March, 1913. The panels of the new bridge were 30 ft. long and the pile bents were to be placed at the panel-points.

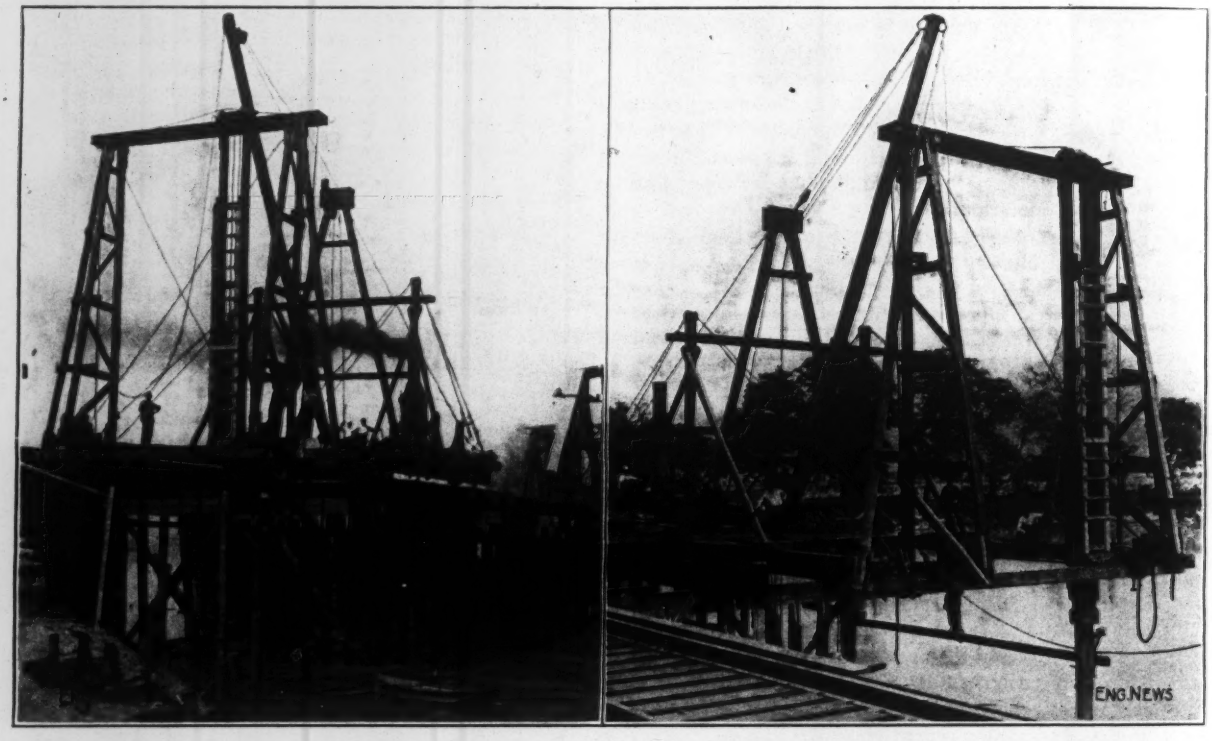
On account of the river conditions and the conformation of the ground at the site, neither a floating piledriver nor a land piledriver could be used to advantage, nor could the piles be reached with a track driver operating from the old structure. As the falsework bents were to be placed 30-ft. centers, a regular track driver (reaching about 16 to 20 ft.) could not be operated on the falsework trestle without driving intermediate bents for the support of the piledriver, which would have been entirely useless in the erection of the bridge. Therefore, the special rig described below was devised as a combination piledriver and falsework traveler that would not only drive the piles at a reach of 30 ft. but also, by means of the swinging boom, place all of the caps, bracing, stringers, etc., for the falsework complete, as the piledriver advanced.

Actually only half the bent was driven in one position of the driver; that is, the falsework was built in two longitudinal halves, one of which could be completed all the way across the river or across one or more spans of the new bridge, before returning to drive and build the other half.

Fig. 1 shows the driver at work. As will be seen there, the essential feature is that the leads are suspended from a transverse runway on which they can travel across a width of about 16 ft.

The drawing (Fig. 3) gives the construction of the driver in detail. The main portion is a traveling derrick frame whose base is extended 30 ft. forward from the mast and stiffened by vertical and lateral guy stays of 7/8-in. wire rope. On the forward end of this overhang is mounted a gallows-frame about 30 ft. high whose top rails consist of two 10-in. I-beams. A pair of piledriver leads hangs between these I-beams, supported on their upper flanges by two 2½-in. rollers which serve as bearings for two knife-edges (vertical plates) in the head of the leads. This detail allows the leads to swing forward or back without binding on the 2½-in. rollers or interfering with the action of the rigging which traverses the leads along the I-beams.

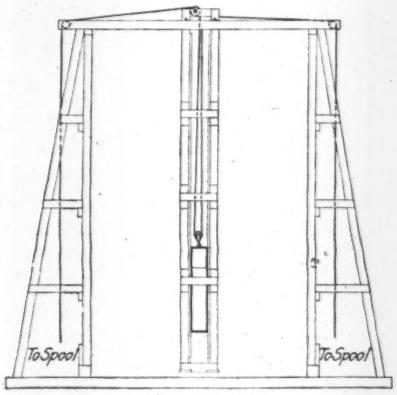
The traversing rigging comprises two side-haul ropes, one of which is the hoisting line of the pilehammer (steam hammer), which passes sideways from a sheave at the top of the leads. The arrangement is rigged as sketched at *A* in Fig. 3. The weight of the hammer offers a greater resistance than the friction of the leads on their



FIGS. 1 AND 2. TWO VIEWS OF THE CANTILEVER DRIVER WORKING ON THE COSHOCTON BRIDGE FALSEWORK

support; therefore the leads will traverse when the two opposing lines are properly manipulated, the movable pulley in the hammer acting substantially as a fixed sheave. When a strain is held on the right-hand line the hammer is raised and lowered by hauling in or paying out the left-hand line.

The foot of the leads clears the top of the lower cross-timber of the gallows-frame, so that after a pile is driven the leads can be swung forward or backward to disengage and clear the pile, and then traverse sideways to drive the next pile. However, a pair of drop bolts is provided by which the leads are held in position with respect to this cross-timber while driving a pile.



Sketch "A"

This piledriver worked in all respects successfully. The 6-pile semibents were driven and capped, stringers and deck laid and piledriver advanced in regular succession, and after completing enough trestle to cover one span or more (one span = 240 ft.), the driver returned and built the second half. The caps of the second half were spliced on the middle line of the trestle to the caps of the first half.

This trestle work was done during the past summer. By Sept. 22, the new steel bridge had been completely erected on the falsework, and was moved over in place of the old bridge.

The bridge was constructed under the general direction of J. C. Bland, Engineer of Bridges, Pennsylvania Lines West of Pittsburgh.

The Seaboard Construction Co., Philadelphia, was the contractor for the entire erection work. S. P. Mitchell, president of the company, devised the special piledriver, as well as the methods and appliances used in the rest of the work.

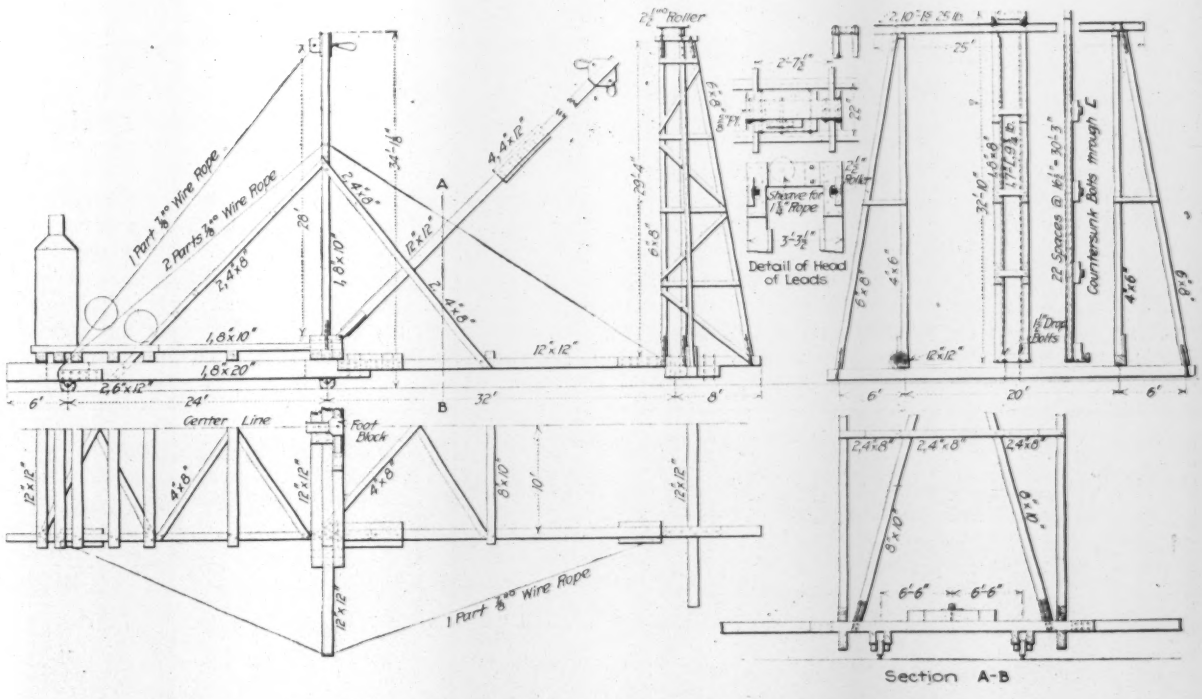


FIG. 3. CANTILEVER PILEDRIVER WITH TRAVERSING LEADS

A Simple Form for Earthwork Computations

BY E. F. VERPLANCK*

A very rapid, compact form of computing from center-line heights the volumes of dams, railroad embankments, canal prisms, etc., for preliminary estimates, has been developed by the writer. There are two general cases, *a* and *b* as follows:

(*a*) *Center-line elevations at 100-ft. stations.*

Directions: Tabulate in vertical columns, for each station, the following quantities:

(1) Present center-line elevation.
(2) Proposed center-line elevation.
(3) Vertical difference between these two elevations, which is the center height of the prismoid.
(4) Square of the center height.

Multiply the sum of the center heights by the top-level

*Engineer, Cape Cod Construction Co., Sandwich, Mass.

width of the prism, if it is in fill, or the bottom-level width, if it is in cut.

Multiply the sum of the squares of the center heights by the slope ratio, i.e., the base divided by the height. If the slopes on the two sides of the prismoid are not the same, multiply by the average of the two slope ratios.

Multiply the sum of these two products by 100 ft. and divide by 27; the quotient will be the volume of the prismoid in cubic yards.

(*b*) *Center-line elevations at irregular intervals.*

Directions: Tabulate in vertical columns, the following quantities:

(1) Station at which elevation is taken.
(2) Present elevation.
(3) Proposed elevation.
(4) Center height of prism (difference between above elevations).
(5) Square of center height.
(6) One-half the difference in stationing between the preceding and the succeeding points, divided by 100. Call this quantity the distance factor.
(7) Product of center height and distance factor.
(8) Product of square of center height and distance factor.

Multiply the sum of the quantities in column 7 by the level width of the prism.

Multiply the sum of quantities in column 8 by the slope ratio.

Multiply the sum of both these products by 100 and divide by 27; the quotient is the volume of the prismoid in cubic yards.

The proof of the correctness of these procedures can be obtained directly from the expression for the cross-section area of a prismoid in terms of its center height, top-level width and slope ratios, and from the "average end area" approximation for volumes in terms of cross-section area.

Pipe-Thawing Motor Truck of the Columbus Water-Works

The accompanying illustration shows the electric generating set of the Columbus water-works used in thawing out frozen water mains and services. For convenient transportation the various parts have been bolted to a frame of 8-in. channels. This is carried by the 2½-ton general-service motor truck of the department; the set is in use during that time of the year when the truck is least wanted for other purposes.

The outfit comprises a 30-kw. direct-current 100-volt 800-r.p.m. generator, driven by a four-cylinder gasoline engine capable of being run steadily at speeds between 250 and 850 r.p.m. There is a radiator and fan proportioned for full-load continuous operation. On a switchboard, between engine and generator, are mounted a voltmeter, ammeter, field rheostat, main switch and circuit-breaker. The operator can control the engine and electrical equipment without moving from one position. Leads from the switchboard fuses go to the slip rings of a cable drum, carried under the right-hand side of the truck body. This drum has two 210-ft. 300,000-circ. mil flexible cables. The cable is rewound by power. Special bronze hand clamps are used to make contact on pipes between ⅜ and 2½ in., and on hydrants, bibcocks, etc.; no tools are necessary.

The plant has a capacity of melting 12 lb. of ice per minute but the melting effect is concentrated on the inside wall of the pipe and only a skin of water around a core of ice is necessary, the core being reduced by the flow of water. It has been found in practice that as soon as a few drops of water show at the delivery point, current may be shut off and the water left to complete the thawing. Unless pipes inside a building are frozen, it is found that best results are obtained when the connection is made as close as possible to the place of entry of the service pipe into the building. The other connection

PIPE-THAWING OUTFIT OF THE COLUMBUS WATER-WORKS

is made to a fire plug if within 200 ft., or else to the pipes in a neighboring house. Two men are required to operate the outfit and truck; these men work at other jobs when there are no pipes to thaw.

Knockdown Camp Buildings

By Charles E. Bee*

Collapsible, interchangeable camp buildings, used in the construction of a canal system for the Southern Alberta Land Co., were erected and used under the supervision of the writer in 1912. In a new 48-mile section of main canal there was a considerable amount of concrete work in the way of drops, headgates, wasteways and reservoir-outlet structures, which was so scattered that it was not feasible to operate from a camp on more than one structure at a time. This required that the camp be moved at approximately three-month intervals.

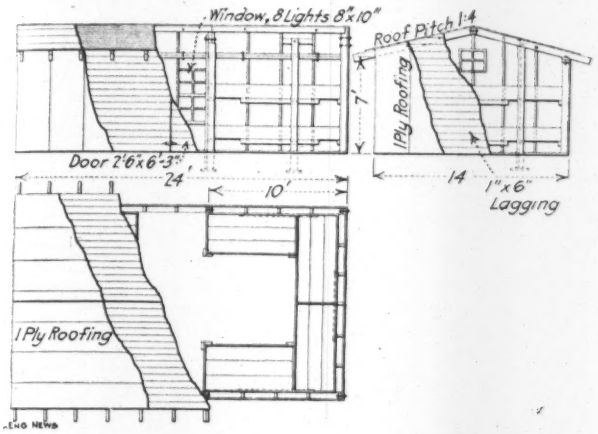


Fig. 1. Design of Collapsible Bunkhouse

(Houses 16 men. All lagging is 1x6 in.; bunks are built of 1x12-in. boards with 2x4-in. supports; frame of building and bunk posts are of 2x6"s.)

The region is not a lumber-producing country, and supplies also were difficult to obtain. As from four to six camps, housing from 30 to 90 men each, would be required until the completion of the work, it was highly desirable that some economic system of camp building be employed.

Standard buildings of a simple collapsible type, with parts interchangeable to a considerable extent, were designed with the following objects in view: (1) To use the same grade and sizes of lumber as would be employed in the formwork for the proposed concrete structures; (2) not to make the camp buildings larger than necessary, in order to minimize moving charges and material costs; (3) to have the design simple and uniform, so as to be readily followed by ordinary carpenters and laborers, and dismantled and erected with ordinary supervision.

TABLE 1. CONSTRUCTION COSTS AND MOVING CHARGES

	Barn 2 Sections Complete with Stalls and Mangers, 24x32 Ft.	Extra Section Complete with Stalls and Mangers, 24x16 Ft.	Bunkhouse Complete with Bunks, 14x24 Ft.	Commissary Bldg., Including Floor, 1 Section, 16x12 Ft.	Extra Section, No Floor, 16x12 Ft.	Blacksmith Shop, Floor of 2-In. Planks, 14x14 Ft.	Foreman's House, Including Floor and Partition, 14x20 Ft.
Lumber M b.m., 1x6 in.†	2.350	0.930	1.030	0.890	0.420	0.700	1.290
Lumber M b.m., 2x6 in.	1.850	0.720	0.920	0.440	0.165	0.440	0.650
Lumber M b.m., 2x4 in.	.....	.....	.....	0.075	.....	.....	0.115
Lumber M b.m., 1x12 in.	.....	.....	0.660	.....	.....	.....	.....
Lumber M b.m., 2x12 in.	.....	.....	.....	.....	.....	0.170	.....
½x6-in. bolts with nuts and washers	20	12	4	.....	.....	.....	.....
½x4-in. bolts with nuts and washers	68	26	35	25	15	25	35
20d. nails	45 lb.	20 lb.	25 lb.	15 lb.	8 lb.	15 lb.	22 lb.
8d. nails	30 lb.	12 lb.	22 lb.	10 lb.	5 lb.	10 lb.	15 lb.
Roofing in sq.ft.	900	450	1030	600	420	245	900
Sashes of 4 lights each 8x10 in.	.....	.....	4	4	2	1	4
Cost of lumber at work	$88.20	$34.65	$54.80	$29.50	$12.30	$27.50	$43.25
Cost of hardware, roofing, etc.	$20.50	$10.10	$20.85	$15.95	$10.10	$6.70	$21.95
Total cost of materials	$108.70	$44.75	$75.65	$45.45	$22.40	$34.20	$65.20
Cost labor erecting	$60.90	$23.90	$37.90	$20.35	$8.50	$19.00	$30.00
Total cost	$169.60	$68.65	$113.55	$65.80	$30.90	$53.20	$95.20
Total weight	9500 lb.	3700 lb.	5900 lb.	3200 lb.	1300 lb.	3000 lb.	4600 lb.
Cost dismantling, loading, hauling* and erecting, including repairs to roof	$65.00	$26.00	$49.00	$27.00	$13.00	$20.00	$39.00

Notes:

* Distance of over five miles and not more than thirteen. For greater distances the cost will slightly increase, and for less than five miles the cost will decrease proportionally.

† Cost of materials includes first cost; 10% for unloading, handling, etc.; and freighting to work.

The general design and arrangement adopted are shown in Fig. 1, while Table 1 gives the material and erection costs and, on the bottom line, moving charges. Costs varied considerably in practice, as the work was done at unequal distances from the railway distributing points, and on account of the human element in the force employed. The table was compiled from average actual costs obtained during a period of two years.

All buildings had a roof pitch of 1 in 4, and in all cases, excepting the barns, the height of the sidewalls was 7 ft. For the barns, walls 8 ft. high were built. The walls of the blacksmith shop and barns were not covered with roofing.

The table following compares the values of a wood

Fig. 2. Taking Down Bunkhouses (Left) and Barn (Right)

*Ithaca, N. Y.; formerly Division Engineer, Southern Alberta Land Co., Medicine Hat, Alta.

portable barn with capacity for 24 head of horses with a tent barn of 26-head capacity. Twice during its year and a half of service the tent was blown down in heavy storms, while no trouble of the kind was experienced with the movable barn. At the end of this period the tent barn was worn out, while the wood portable barn was still in service and in first-class condition.

TABLE 2

	First Cost	Moved 6 times from 2 to 15 Miles	Mending Tent	Setting Up after Storms	Value at End of 2 Years	
Wooden-barn, 24x48 ft.	$238	$546	.....	.....	$200	$584
Tent-barn, 28x54 ft.	$200	$282	$75	$20	.....	$577

NOTES

An Electric Road-Roller is a feature of the equipment of the United Railways Co., of St. Louis, Mo., being used on paving or repaving work. The machine is of the drop-frame type, but in place of the usual vertical boiler standing on the frame there is an electric motor geared to a shaft having a sprocket chain drive to the shaft which carries a bevel pinion engaging a bevel gear on the face of the roller. Above the motor is the controller, handled by a man sitting on the upper end or goose-neck of the frame. A frame over the roller carries a horizontal drum or grooved pulley for the wire conductor. The machine requires about 15 hp. and has a speed of 4 m.h.p. when rolling. Its weight is about five tons.

Some Odd Uses of Culvert Pipe—The accompanying illustrations show some interesting examples of the use of corrugated ingot-iron culvert pipe for purposes other than those for which it was designed. Fig. 1 shows a survey monument used on the boundary line of Stanislaus County, Calif., by County Surveyor E. H. Annear. The monuments are made of 20-gage American ingot-iron corrugated culvert pipe, 6 ft. long, and made to taper from 23 to 12 in. They are set in holes 3½ ft. deep and filled full of concrete. Fig. 2 shows two of three highway bridge piers built of a pair of concrete-filled culvert pipes each. This was a bridge in Tulare County, Calif., built by Robert Horbach, County Supervisor, in the summer of 1913. The following February the extraordinary floods carried away the bridge, but the piers remained standing, uninjured, and it was a simple matter to replace the superstructure. The pipe was made by the National Corrugated Culvert Manufacturing Co., Middletown, Ohio.

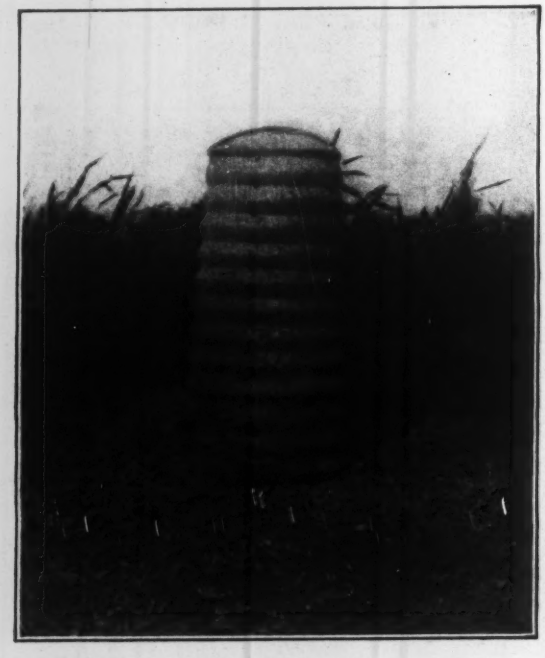
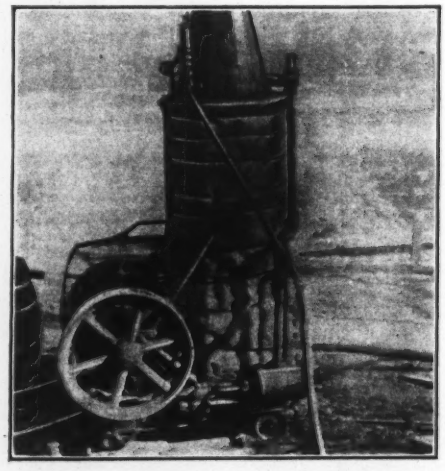


FIG. 1. CORRUGATED INGOT-IRON CULVERT PIPE AS A SURVEY MONUMENT

FIG. 2. CORRUGATED INGOT-IRON CULVERT PIPE FOR BRIDGE PIERS

Overcoat for Boiler—Contractors who have had the usual troubles in making a little boiler steam well on outside work in cold weather will note with interest the covering used by H. Tappendorf on the concrete work of the Y. M. C. A. building at Streator, Ill. There was about ½ in. of heavy felt insulating paper covered up with heavy waterproof roof sheeting.



AN IMPROVISED BOILER COVERING

Auxiliary Pumping Plant for Floating Caisson—A pumping plant, mounted on an old barge, has been assembled for use as an auxiliary to the pumping system of the floating caisson for the Panama Canal Locks. There are two 18-in. centrifugal dredging units driven by 655-hp. motors. These pumps were formerly used for the removal of spoil from the channel south of the Miraflores locks. A 10x10-in. motor-driven vacuum pump in used for priming. When a lock chamber is to be pumped out the floating outfit will be towed inside and moored alongside the lower gates. To provide for discharge as the plant lowers, two standpipes, rising 60 ft. above the pumps and clearing by 1 ft. the highest gates alongside which the outfit will be used, have been erected on the barge. The standpipes can be lowered by means of ball-and-socket joints. Electric current is transmitted from lock walls to barge through a flexible cable. The rated capacity of the plant is about 17,500 gal. per min. The outfit is awaiting test at the present time. The large floating caisson or gate used for unwatering the Panama Canal lock chambers, and its equipment and pumping system, were fully described in "Engineering News," Dec. 3, p. 1099.

Brick Paved Roads constructed by the Ohio State Highway Commission in 1914 aggregate 164 miles, and the average contract price per mile is $20,827. The average contract price per foot of width is $1364. Besides the brick paving, this contract price includes grading, draining, curbing and building necessary bridges and culverts.

Editorials

Why Not Increase the Corps of Engineers?

At this time of general inquiry concerning the extent to which the United States is prepared for war, it is of interest to raise the question anew why the Corps of Engineers of the Army is still allowed to remain deficient in numbers. For years the Chief of Engineers urged Congress to increase the Corps, so that sufficient men might be available to perform its many duties. Congress acted upon this recommendation in 1911, authorizing the annual appointment of 12 additional second lieutenants from civil life to membership in the Corps of Engineers. The law, however, has been allowed to remain a dead letter. But two appointments have been made under its provisions and the only additions to the Corps of Engineers during the past year were 15 graduates of West Point, although there now remain 24 vacancies in the grade of second lieutenant in the Corps.

In the current discussion over the question whether the United States is well prepared for national defense, it has been made clear that one of the directions in which a shortage would soonest occur in time of war would be in trained and efficient officers. Under the conditions of present-day warfare, as is every day exemplified, the military engineering organization is an absolutely essential factor in the effective prosecution of a campaign. The United States has in its numerous high-class engineering schools and in recent graduates of such schools a source for all the engineer-officers that it may require, needing only the addition of the special military training.

The Corps of Engineers should be brought up to its full strength now authorized by law, not merely for the possible emergency of war, but because, according to the repeated official statements of the head of the Corps, the full number of officers is needed to carry on the work of the Corps in time of peace.

The old barriers of prejudice between the officers of the corps and their civilian brethren have been, we believe, pretty thoroughly broken down in recent years; and there could be no better way to effect their permanent removal than to at once fill up the Corps of Engineers to its full strength by the appointment to it of competent engineers from civil life.

⌘

Coal Production in the United States as an Index to Industrial Development

Statistics of coal production in the United States from 1807 to the close of 1913 have just been issued by the United States Geological Survey. Their striking feature is the enormously rapid increase in the production which has taken place in very recent years. According to these statistics, as much coal has been taken from the coal fields of the United States in the eleven years from 1903 to 1913, inclusive, as was mined from them in all the years preceding, from the beginning of the industry. More than twice as much coal was mined in the year 1913 as in the year 1900. Nearly four times as much was mined in 1913 as in 1890. Eight times as much was mined in 1913 as in 1880, and seventeen times as much as was mined in the year 1870.

A movement for the conservation of natural resources would have had little meaning a generation ago, since the amount then taken annually from the accumulated mineral resources of the nation was a mere trifle compared with today. In 1913, however, 570,000,000 tons of coal were mined in the United States; and it must be remembered that under present wasteful and destructive methods of mining, which are made compulsory by the sharp competition, a very large proportion of the coal in the seams is left in the mines, and made forever unavailable for the use of the human race. Actually, therefore, we are using up the stock of available fuel stored in the coal beds, not at the rate of 570 million tons a year, but at the rate of nearly a billion tons a year.

These figures of coal production, however, are of interest also as an index of industrial and commercial development. Broadly speaking, they record the change of the United States from a nation engaged chiefly in agriculture, exporting its raw materials and importing such few manufactured goods as were not made by home industry, to a commercial and industrial nation. When one considers how essential coal is to all the operations of our present-day civilization, it seems well nigh incredible that less than a century ago practically the sole fuel of the United States was wood. Doubtless the early statistics are more or less imperfect, but on their face they show a total of only 15,000 tons of coal mined in the entire United States in the thirteen years from 1807 to 1820. Not until 1825 did the annual coal production of the United States exceed 100,000 tons. Not until 1837, a dozen years after the beginning of the railway era, did it exceed a million tons. Sixteen years later, in 1853, it had passed the ten-million-ton mark. Twenty million tons was passed in 1863, and thirty million tons in 1867. Not until 1882, however, did the annual production exceed one hundred million tons.

⌘

An Original Plan for Advertising an Engineering Society

Mr. Harrington Emerson, of New York City, who is well known as a man of great originality in devising methods of publicity, has recently put into practice a remarkably ingenious plan for making better known to the members of the American Society of Mechanical Engineers the facilities which are available to the members at the Society's headquarters in New York City.

To lay a foundation for this ingenious scheme, Mr. Emerson sent out a circular letter to the members of the Society on Nov. 24, expressing general dissatisfaction with the way the Society was conducted, and declaring

that it ought to do more for the benefit of its members. He followed this up on Dec. 15 with another circular letter to the membership, in which he became specific in his criticisms and declared that he would like to see the Society at its headquarters offer the following facilities to its members:

(a) Rooms for the transaction of temporary business, as meetings of members of a company.

(b) Writing and other temporary study facilities, including stenography and typewriting for out-of-town and local members who are preparing reports, etc.

(c) The receipt and forwarding of mail.

(d) A dressing room for members coming into the city for an evening.

(e) A research bureau at the disposition of members, which would consult books, pamphlets, periodicals in the library for members, especially nonresident members.

To make this circular letter still more impressive to the membership, Mr. Emerson inclosed with it a question blank to be filled out and signed by the members and returned to him, indicating whether or not they desired to have the Society furnish the several conveniences enumerated above.

All this may seem like a formidable criticism of the manner in which the American Society of Mechanical Engineers has been conducted, and very likely it will be so construed by a large proportion of the membership. It is not, however, because each one of the above named facilities is already afforded by the Society to its members and has been for years. The fact that these facilities are available to them, however, has probably been unknown to a large part of the membership, or if they knew it, they have forgotten it.

Mr. Emerson, however, whose business it is as an efficiency engineer to know all that is to be known on a great variety of subjects, is doubtless well aware that the Society has made available to the membership the various conveniences; and he has therefore taken the singularly effective method of bringing them to the attention of the members in a way which they are not likely to forget. The result will doubtless be a great increase in the use of the Society headquarters by the members and greater appreciation of the value of their Society membership.

The Compensation of Civil Engineers

A year ago great interest was aroused in the engineering profession by the report of a special committee of the American Society of Civil Engineers appointed to investigate the conditions of employment of and the compensation of civil engineers. The report of this committee, with an accompanying diagram summarizing reports of annual earnings from 3638 members of the Society, was published in our issue of Jan. 22, and was followed by much comment and criticism.

In the *Proceedings* of the Society for December, is printed a second progress report by the above named committee, giving the results of their further and more thorough investigation. The committee states that following its report last January, it sent out a second circular of inquiry to the membership on May 22 last and received

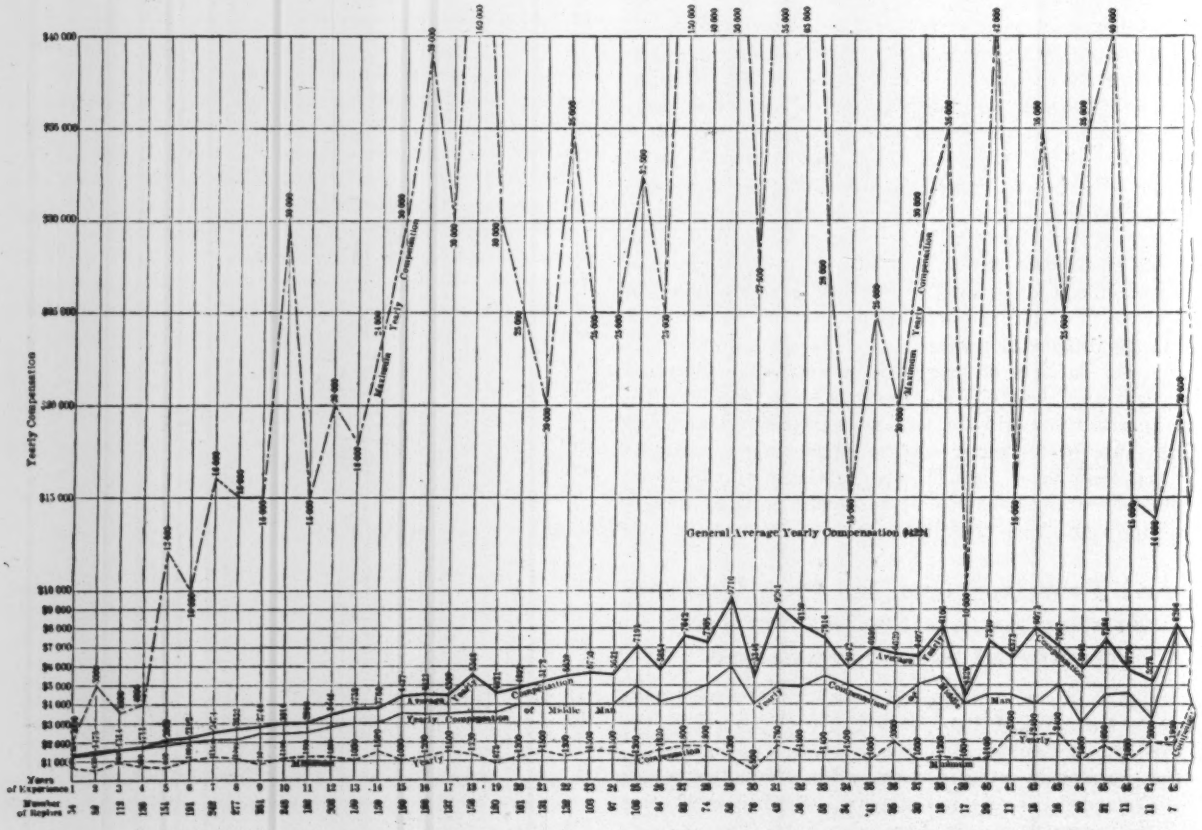


FIG. 1. DIAGRAM SHOWING YEARLY COMPENSATION OF 4796 MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

replies thereto from 1158 members with such information as permitted of tabulation. The statistics which the committee now presents cover, therefore, 4796 members of the Society, or two-thirds of the entire membership. The accompanying diagram (Fig. 1), reproduced from the committee's report, shows the highest, lowest and average yearly compensation of these engineers, classified according to their years of experience.

It also shows the yearly compensation of the middle man in each group, which, it will be seen, is quite different from and very materially lower than the average yearly compensation for the group as a whole. This means, of course, that the line representing the average yearly compensation is raised materially above what it would otherwise be by the high earnings of the comparatively few members of the profession who are in receipt of very large incomes. It is a reasonable conclusion that the curve representing the yearly compensation of the middle man fairly represents what the average civil engineer may hope to look forward to, provided he obtains that prominence in the profession which is represented by membership in the American Society of Civil Engineers.

With reference to the few men who receive the highest rates of compensation, ranging from $25,000 to $150,000 per annum, the report gives no indication of the actual number of these exceptional individuals, nor does the report on its face indicate whether these high annual earnings are the result of strictly professional work or of engaging in business. But in another diagram presented by the committee, reproduced in Fig. 2, comparison is made of the earnings of engineers employed on a salary by railways, cities, etc., and engineers engaged on their own account in consulting-engineering work and in contracting. Both these latter terms are exceedingly elastic in their application; and there is little room for doubt that nearly all of the high rates of engineering compensation listed by the committee are the result of engaging in business, and not by any means the result of professional fees.

The criticism will doubtless be made that it is distinctly unfair to use the incomes received by a few exceptional engineers, who have abandoned professional work to go into engineering business, as a basis on which to make up averages representing the average earnings of those engaged in professional engineering work alone.

The committee making the investigation may very well say, however, that it is impossible to draw any hard and fast line between earnings from engineering followed as a profession and earnings from engineering carried on as a business; and that the members of the Society who report annual earnings of $25,000 to $150,000 a year may very well claim that they are enabled to make these exceptional incomes by reason of their professional knowledge and experience as well as their other exceptional qualifications.

It may be well, however, to add a word of caution at this point. Unless great care was taken, it is likely that there may have been some errors in interpreting the returns received from those engaged in contracting or in carrying on an independent consulting practice. Those who engage in the contracting business have to put at risk a larger or smaller amount of capital and from their gross annual receipts should be deducted not merely the interest on the capital invested, but enough returns in addition to compensate for the very considerable risk of loss that must be incurred by those who play in this game. If this has not been done, then the "annual compensation" of those engaged in contracting has been overstated. Likewise, in order to make the compensation of the consulting engineer comparable with that of the engineer on a salary, there should be deducted from the consulting engineer's earnings his office and traveling expenses and a reasonable return on whatever capital he may have invested.

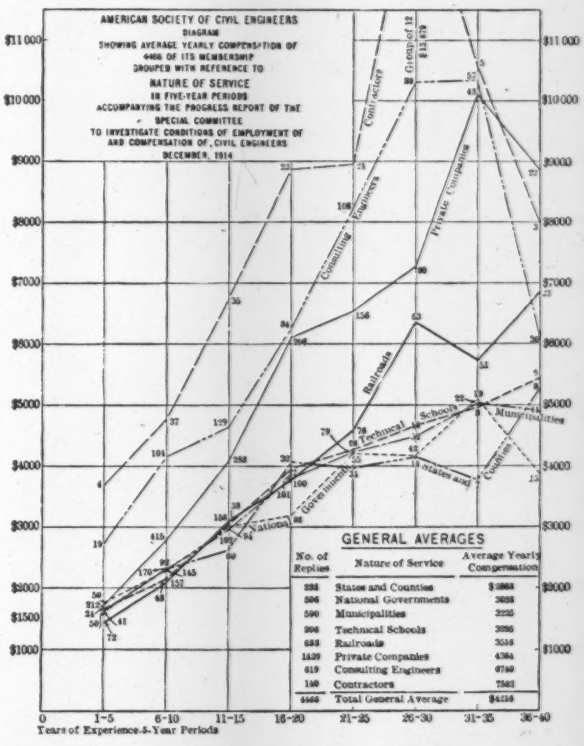


FIG. 2. DIAGRAM SHOWING AVERAGE YEARLY COMPENSATION OF 4466 MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS CLASSIFIED BY THE KIND OF SERVICE RENDERED AND GROUPED BY FIVE-YEAR PERIODS

There is, of course, no reason to doubt that many of the engineers who have gone into the contracting business or who have acquired great fame and a lucrative practice as consulting engineers—which term by the way often includes those who are really carrying on a business in the design and construction of engineering works—there is no reason to doubt, we say, that members of the engineering profession in these fields do, in some instances, make very large profits.

On the other hand, there is a very considerable number of engineers in both consulting work and contracting, who think themselves lucky to be able at the end of the year to clear as much net profit as the average engineer on a salary; and some of them at the end of a year like that just closed find their net profit represented by a minus quantity. There are, undoubtedly, prizes to be won in the contracting game; but those who would enter it should understand also the chances that they may draw a blank.

The diagram, Fig. 2, in which the engineers reporting are classified according to the nature of their employment, ought to be especially studied by those who are interested in the problem of government. It is there shown that

the engineer working for the national government, or for a city, state or county, is not only subject to all the uncertainties of political control and doubtful tenure of office, but receives a lower salary than engineers engaged in railway service, and far lower pay than the engineers employed by other corporations.

The committee further endeavored to investigate the relative compensation paid to engineers in different parts of the country. It classified the replies received from five geographical divisions of the United States, and from engineers resident in foreign countries. We do not reproduce the diagram made from this classification as the results it shows are so confusing and contradictory that it can hardly be esteemed of much value. About all that it shows is that the average compensation of the members of the Society reporting who are resident in foreign countries is considerably higher than that reported by those in the United States. This is readily explained from the fact that most of the members of the Society who go abroad do so on important engagements, such as come to men of special prominence in the profession and naturally bring them higher rates of compensation. For the rest, the diagram shows merely that the rates of engineering compensation in the Southern states are lower than those in other parts of the country, and that the average rates in New England and the Far West are higher than those in the Middle States and the Middle West. The average for the Middle States, as well as for the Middle West, is doubtless materially raised by the high earnings of prominent engineers in such engineering centers as New York and Chicago.

We do reproduce, however, in Fig. 3, a diagram com-

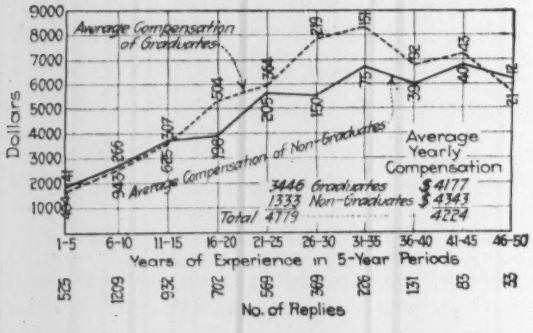


FIG. 3. DIAGRAM SHOWING AVERAGE YEARLY COMPENSATION OF 4779 MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS GROUPED AS GRADUATES AND NONGRADUATES IN FIVE-YEAR PERIODS

piled by the committee showing the comparative compensation of engineers who are graduates of technical schools and those who are not. Examination of the diagram shows that for the first fifteen years after graduation the graduate engineer receives substantially the same salary as the engineer who has gained his professional knowledge by experience and home study. After fifteen years a rather wide gap appears to open between the two classes.

The committee suggests that this advantage of the graduate over the nongraduate in the later years may be due to the thorough grounding in fundamentals which engineers received who graduated fifteen to forty-five years ago, which grounding helps in their advancement in later years of professional practice. It may be suggested also that the benefits which an engineering education is supposed to give in the way of general culture, ability to deal with and manage men, and to impress them by writing and speaking, are effective in promoting an engineer to a position of higher responsibility after he has worked through the lower ranks of the profession.

There is, however, one additional comment that should be made in studying this diagram, and that is that in the diagram graduates and nongraduates are compared on the basis of equal years of experience, and the experience of the graduate is assumed to begin when he leaves the engineering school. For a fair comparison, however, the graduate's experience should be assumed to begin when he enters the engineering school. Although he receives no pay for his work, he begins from that time to devote himself to his profession. The nongraduate likewise begins to learn the profession when he starts work in it. For a really fair comparison, therefore, the curve representing the compensation of graduates should be moved horizontally to the right some distance, and this would make the difference between the compensation of the two classes materially less on the average. Further force is given to this suggestion by a table which the committee presents showing that the average age of the nongraduate reporting a certain number of years of professional experience was somewhat less than the age of the graduate reporting a similar length of experience.

The two questions of chief interest in connection with this investigation are, first, whether the figures are fairly representative of the compensation received by the members of the American Society of Civil Engineers, and, second, whether the compensation of these men may be taken as fairly representative of the compensation received by the average man engaged in civil-engineering work.

As to the first of these questions, it has been urged that the one-third of the members who did not answer the committee's circular of inquiry were doubtless influenced in many cases by unwillingness to report the amount of their comparatively modest salaries. The committee, however, does not accept this view of the case, because the 1158 replies which it received to its circular showed about the same average rates of compensation as the replies received to its first circular which were tabulated a year ago.

As to the second question, however, there can hardly be two opinions. The membership of the American Society of Civil Engineers, including those in the lower grades as well as the full members, undoubtedly represent selected men. In fact, the qualifications fixed for membership in the Society are intended to effect that very thing. Since high professional ability is a requisite of membership in the Society, the members of the Society ought to be in receipt of materially larger earnings than the rank and file of the profession. There is no reason to doubt that this is actually the case.

The committee announces that in view of the criticisms which have been made of its report as not representing the earnings of the average engineer, it proposes during the coming year to collect statistics as to the compensation of those engaged in engineering work who are not members of the Society, and to make a classification of such statistics based on the age of those replying as well as upon their years of experience. It also proposes to supplement this information by an inquiry as to the proportion of

time during which engineers are out of employment. There seems no reason to doubt that at the annual meeting of the Society this month the committee will be instructed to continue its work on the lines thus marked out.

During the past twenty years, many youths have been influenced to take courses in engineering schools and in correspondence schools by the publication of glowing advertisements, setting forth the great earnings of engineers of high rank, and by the publication of statistics based on incomplete and unreliable data, showing the remarkable degree of financial success attained by graduates of some of the engineering schools.

Some of the over-crowding of the profession which has cut down the rates of compensation is probably due to the men who have been brought into it by such methods. It is, therefore, a very proper public service for the leading society devoted to civil engineering to collect accurate statistics bearing on this subject for the benefit not only of its own membership but of those youths who may be looking toward the engineering profession as an occupation.

Letters to the Editor

The Election in the American Society of Civil Engineers

Sir—Referring to your editorial in the Dec. 31 issue entitled, "Contests in Engineering Society Elections," having reference to the candidacy of Geo. A. Harwood as against F. A. Molitor, for Director of the American Society of Civil Engineers from District No. 1, you state that the opposition to the latter gentleman is based on a criticism of the Society published in ENGINEERING NEWS.

The writer feels that you have not read all the circulars otherwise you would have seen that the most important reason for the contest is that Mr. Harwood was the nominee selected by the representatives of District No. 1 and Mr. Molitor was not. It is clearly established that Mr. Harwood's name was presented for Director by the three members of the Nominating Committee in District No. 1. It does not appear that any question was raised as to his standing or capability, yet he was defeated by a vote of eight to six through a combination of members of the Nominating Committee outside of District No. 1.

The main question at issue in the writer's opinion is, therefore, whether or not a district may be permitted to select its own candidate through its representatives on the Nominating Committee.

The idea that the outside districts can combine to deprive a district of unimpeachable representatation of its choice, is to my mind an infringement on representative rights.

There is a curious inconsistency in the circular sent out by Mr. Molitor in which he states that he is in favor of constitutional changes "empowering each district to select its own Directors." If he consistently believes in this principle, why does he violate it in opposing Mr. Harwood?

A. W. CARPENTER.

New York, Jan. 2, 1914.

[In accordance with our usual rule, a copy of the above letter was submitted to Mr. Molitor to give him opportunity to make reply in the same issue. His answer follows.—EDITOR.]

Sir—I desire to thank you for the opportunity to answer the letter of Mr. Carpenter.

Mr. Carpenter states that my opponent's name was presented "by the three members of the Nominating Committee in District No. 1." As a matter of fact there are but two members of the Nominating Committee from any district.

The proceedings of the Nominating Committee are understood to be confidential, therefore, perhaps a similar mistake has crept into his statements respecting the vote for and against me in the Nominating Committee.

Mr. Carpenter states that "the main question at issue . . . is whether or not a district may be permitted to select its own candidate." The Constitution provides for the nomination of all officers and directors by the Nominating Committee as a whole and *not* by districts, hence, there can be no inconsistency in my stating that I am in favor of empowering each district to select its own directors. To follow Mr. Carpenter's argument would be unconstitutional.

My nomination as Director from District No. 1 was unsought and I know nothing of the conditions surrounding the same. In accepting it and running for the office I am merely carrying out the will of the *majority* of this Committee, who, it is presumed, nominated me in accordance with the requirements of the existing Constitution. It would seem that my opponents are seeking to enforce the will of a minority, resident in New York City. Many members of the Society feel that its affairs have been run for the benefit of a small minority in New York City, therefore, it may be presumed that I was nominated because of the reforms for which I am known to stand.

If a member is dissatisfied with the manner in which he has already cast his ballot in this unfortunate controversy, let him be reminded that Article VII, paragraph 6, of the Society's Constitution, permits him to withdraw his ballot and substitute another any time before Jan. 20.

F. A. MOLITOR.

New York, Jan. 4, 1914.

Phonograph Disk Records Not Inflammable

Sir—In the account of the Edison fire contained in your issue of Dec. 17, 1914, the contents of the buildings were referred to as "film stock, phonograph cases, phonograph disks and cylinders, packing boxes and office records, all except the latter being highly inflammable." Condensite, of which the Edison diamond disk record is

made, is not highly inflammable or even readily so, and the many tons of condensite records which were stored in the Edison works were but partly consumed.

KIRK BROWN, President,
Condensite Company of America.

Bloomfield, N. J., Dec. 19, 1914.

Comments on the Edison Fire

Sir—The photographs and facts which you published in your issue of Dec. 17, 1914, p. 1233, concerning the Edison fire, and the editorial emphasis which you place on the same, are or ought to be epoch making.

I refer particularly to the one great big fact that this fire has demonstrated beyond a shadow of a doubt, namely, that the rodded concrete column has been weighed in a fire and found totally wanting. It has been weighed in innumerable wrecks and found woefully bad. It remains for this costly fire to demonstrate its utter unfitness for any structure.

If only insurance and bonding companies can see and appreciate the facts that this fire has demonstrated, it will not take engineers long to change their views. Reforms in a profession generally come from outside pressure.

This fire has demonstrated not that reinforced concrete is a failure but that the rodded column is a failure, but it is hard to derive much comfort from the fact that the "remarkable toughness of the reinforced-concrete frame was evident," if that frame has to be torn down because the builder was so short-sighted as to support it on these miserably brittle and unreliable props.

EDWARD GODFREY.

Pittsburgh, Penn., Dec. 19, 1914.

Sir—The writer would like to call attention to one matter touched upon in your report of the Edison fire, which it seems to him is not sufficiently accented.

An examination of the pictures would seem to indicate that the columns did not have any column ties or lateral reinforcement. You call attention to this fact as follows:

Evidently the action is as follows: Under the heat of the fire the longitudinal steel rods (which were only at the four corners, and evidently not tied horizontally) expand, and in expanding, force off the outside coating of concrete.

The writer has no criticism to make of this statement, and the only criticism of the article as a whole is that it does not seem to lay sufficient stress upon the above fact. It seems to the writer that the departure from standard practice in the omission of lateral support for the reinforcing bars is sufficient in itself to account for the whole of the damage done to the reinforced-concrete work in these buildings.

Although the concrete and the metal may have substantially the same coefficient of expansion, the average temperature of the column, as a whole, was necessarily much below that of the reinforcing rods, and the resulting relative elongation of the reinforcement, as compared with the concrete, being multiplied many times in the tendency to lateral movement, causes a powerful bursting action on the concrete envelope, much beyond the tensile strength of the concrete to overcome.

Certainly the disastrous effect would have been much decreased had metal window frames, with wire-glass, been employed. The legitimate function of metal window frames, however, is to save the contents of the building rather than the building itself, although they do operate in the double capacity. At the same time, had the columns in these structures been properly designed, it is the writer's opinion that no material damage would have been done to the building.

Reinforced-concrete experts have nothing to learn from this disaster. The lesson to the owner or prospective builder however, is that the designing of reinforced-concrete buildings is a highly specialized science, not to be entrusted to any but those who are recognized as experts of long standing and success in this particular line.

A. L. JOHNSON,
Vice-President, Corrugated Bar Co.

Buffalo, N. Y., Dec. 23, 1914.

Sir—In your editorial on the Edison fire, you suggest the unreliability of straight-rodded reinforced-concrete columns as a lesson to be drawn from their behavior in the Edison fire. In the description of the fire in the same number, the conclusion is drawn that the expansion of the vertical rods forced off the concrete outside of them.

The columns in question are square in section, and the occupancy of the buildings indicates that they were very rapidly heated. Under these conditions, unequal expansion would be inevitable; and, the corners of the square section being specially exposed, the concrete would naturally split off across the corner along the section weakened by the presence of the steel rod. Most of the damaged columns shown in the photographs seem to show this action very clearly. The coefficients of expansion of steel and concrete are nearly the same, but the rods would be heated more than the interior of the column and would assist in forcing off the outside concrete. These vertical rods were apparently not tied horizontally, while the best practice today demands very substantial binders, which in a measure must prevent horizontal deflection.

If the splitting of these square columns was due to unequal expansion, the most perfect form to resist such action would be cylindrical. The hooped columns which stood the test were cylindrical. No doubt the hooping increased their resistance, but there is no reason to think that they would have suffered severely had they been reinforced with vertical rods and binders instead of hooping. The expansion of the hooping would also tend to spall off the outside concrete and expose the steel.

C. S. WHITNEY.

Ithaca, N. Y., Dec. 19, 1914.

Sir—The writer believes that a considerable and disproportionate dehydration was the primary cause of failure of the concrete in the Edison buildings. It is quite apparent that the columns would suffer most severely from such a condition. A 20-in. column, for instance, with a shell of dehydrated material 4 in. thick all around would suffer a loss of nearly $\frac{2}{3}$ of its original strength. The consequent deformation under stress would necessarily cause the outside unsound shell to splinter and spall off and also cause the loose rods to buckle. This is actually the appearance of all the failed columns. Special attention is called to the manner of the spall and the splintery appearance of the faces of many of the columns—all indicating the failure of columns under overstress.

One fact of the fire stands out clearly. All those structural members which had failed wholly or in part were clear of soot, and showed that peculiar blanched appear-

ance of concrete that had been subjected to intense heat. Likewise in no place were there evidences of primary failure where the concrete was discolored by soot. In these undiscolored areas of apparently intense heat, large bulky pieces could be pulled loose by hand from the faces of the failed columns. These pieces would crumble quite easily. Picking with a piece of sharp iron at the fractured surface of a column from which a piece about 4 in. had fallen, showed a dull and not the livid streak that one makes on live concrete. The cement was dead, dehydrated deep into the columns. The exposed faces of all the badly spalled but unruptured columns, all had the appearance of dry gravelly earth.

The writer thinks that had these rectangular columns been provided with the usual rectangular bands to tie in the longitudinal reinforcement, the columns would still have failed, due to the lateral, radial flow of the dangerously weakened and highly overstrained material. A properly designed spirally wound circular column (or core) would not have failed; lateral flow would have been stopped in the incipient stage, which in turn would probably have stopped further dehydration.

Dehydration in reinforced-concrete members subjected to stresses that tend to cause a flow of the concrete should form a fruitful source of future investigation.

MAURICE X. C. WEINBERGER.

34 Jefferson Ave., Brooklyn, N. Y.
Dec. 29, 1914.

Sir—It appears that some conclusions can be drawn from the reports of the Edison fire as published.

From a fire-resisting point of view, the weakest members of a modern building are almost invariably the columns, whereas they should be the strongest. The relative weakness of the columns was demonstrated in San Francisco as well as at this fire at the Edison plant.

In reference to the columns which failed by the apparent buckling of the longitudinal rods, the following is submitted as worthy of consideration:

The natural tendency of these concrete columns, enveloped in a very hot fire is to spall at the corners and assume a rounded form. The outer portion of the concrete must have gotten hot before the steel rods did. It seems not improbable that it may have gotten sufficiently hot to come off before the rods were hot enough to expand appreciably. In other words, the initial failure may have been in the concrete outside the rods, separating from the remainder of the columns along the line of the rod as a line of weakness. If this is true, the buckling of the rods may have been the effect and not the cause. Whether settling this question would be of much practical importance is doubtful. However, there is one point which, to the writer, seems very important: Whether we desire it or not, the material included in current designs for fireproofing purposes necessarily participates in the load-carrying duties of the column. There is no reason to suppose that it is not under as severe structural stress as the remainder of the column. When attacked by fire, new and severe stresses of another kind are superinduced. The combination of stresses very speedily brings the material put on for fire-resisting purposes to the failing point; as it is integral with the "structural core," the failure of the exposed material carries with it the failure of core. It is doubtful whether there are five per cent. of the columns in so called fireproof buildings, whether of steel covered with fire-resisting material, or of reinforced concrete, which would have stood the test at the hottest points of this Edison fire. The fact that the fireproof covering almost invariably participates in the load-carrying duties of the column is a sufficient explanation of this in those cases where the column is well fireproofed; the flimsy and inadequate nature of the fireproof coverings in the cases where they do not participate in structural stress would produce the same results under the same conditions.

If the above ideas are correct, it is highly desirable to design columns so that the load-carrying part, i.e., the structural member proper, shall be sufficiently strong and also able to endure a moderate increase of temperature without damage; it should then be covered by material capable of resisting a very high temperature and of keeping the column itself relatively cool. This outer covering should be so applied that it cannot participate in the structural stress in the column itself. This would add considerably to the cost per lineal foot of the column covering, but it would be only an insignificant addition to the cost of the building as a whole.

Whether the fireproof covering is made structurally independent of the column or not, the amount of covering accepted as satisfactory in correct practice is, in no case, sufficient for such important members as columns. In these cases the records of great fires of the recent past prove very clearly that not less than 4 in. of concrete or of brickwork ought to be provided; 4 in. of hollow tile is not an adequate covering.

It is reported that most of the concrete in some of these buildings at the Edison plant seems to be practically undamaged. It is probable that much of it was heated practically to incandescence for some time and that it had subsequently cooled off without the application of water to the hot concrete. It would be very important to make some actual tests of the portions of these structures which have thus come through without visible damage. If these tests should prove that the concrete actually is undamaged, the result would be quite reassuring. The writer's experience in examining such concrete in Baltimore and San Francisco, however, led him to suspect that adequate tests would show such concrete very seriously damaged and very much impaired in structural value, notwithstanding its apparent intact condition. It would seem that this fire had afforded an opportunity to settle some of these questions.

If, in designing columns, the factor of safety, from both a structural and a fire-resisting point of view, be made adequate and of equal value in the two types, it is doubtful whether there is any economy in a reinforced-concrete column as compared with a fireproofed steel column. In the members subjected to a transverse stress, i.e., in the floor systems, there is a real and undoubted advantage with the reinforced concrete as compared with steel beams and girders adequately fireproofed. But if resistance to fire and loads is to be the same in both cases, the advantage in economy would probably lie with the steel column, though the difference would not be very great.

JOHN STEPHEN SEWELL.

Gantts Quarry, Ala., Dec. 22, 1914.

[In connection with our previous report on the Edison fire and particularly in view of the above requests for investigation of the quality of the fire-swept concrete, the following abstracts from the preliminary report of Ira

H. Woolson to the National Board of Fire Underwriters is interesting:

Although these concrete structures were seriously injured by this fire, we should not, therefore, lose confidence in well constructed buildings of this type. In several respects these buildings were not well constructed. The concrete was on the whole of fairly good quality, however, considerable variation existed in both quantity and quality of the aggregates used. This irregularity in composition may have contributed to the failure of the concrete. The cement was evidently of good grade.

The arrangement and placing of the reinforcement was very bad. Whether this was due to faulty design, or careless workmanship we are at present unable to state. There is not a single tie to be seen around the vertical rods in any column, and the lapping of the rods was very carelessly done. The number and diameter of such rods were quite inadequate for the size of the columns. If a sufficient number of properly tied rods had been used probably most if not all column failures would have been prevented.

The reinforcement in the beams was improperly spaced, and very few stirrups appear to have been used—many beams have none at all. Some of the few stirrups used were simply lapped under the bottom of the beam rods.

There were many defects which would never be permitted in first class reinforced-concrete work today. These defects coupled with the rapid expansion of the structures, due to the quick, hot fire, were undoubtedly the cause of the failures in the concrete.

It is also evident that the square type of column is not suited to withstand such a fire. If well designed round, hooped columns had been used, it is probable that the results would have been quite different.

The forthcoming series of fire tests to be made at the Underwriters' Laboratories, upon full size loaded columns, to determine the efficiency of different types of protective coverings, will have an added significance as a result of this fire.

It is expected that a final report, with results of tests, will be ready in a few weeks.—EDITOR.]

A Practical Motor Snow Plow Made from a Road Scraper

Sir—While in Pittsburgh the other day taking up some matters with the Resolutions Committee of the Snow Removal Conference, I saw the accompanying illustration of a road scraper attached to a motor truck for clearing streets of snow.

J. F. O'Toole, Superintendent of Streets, Pittsburgh, who originated this scheme, has informed me that the results have been very satisfactory, and that these plows in a recent storm in Pittsburgh, where there was a snowfall, I believe of 8 in., worked admirably and greatly facilitated the department in the removal of the snow.

As this is the first practical application of the use of automobile plows for snow removal in any of our large cities, and as it is also an indirect result of the agitation brought about by the Snow Removal Conference, I thought the information, if published now, might be circulated in time to permit a number of Eastern cities which have not had any serious snowstorm thus far to rig up some of their motor trucks with these road scrapers.

Mr. O'Toole informed me that the entire cost, including all the work and parts used in attaching these scrapers to the trucks, was only about $17. Of course, the front part, the axle and wheels of the road scrapers can be attached again in the spring, and they can be used for the ordinary road work.

This attachment could not be used very readily on some small streets where there might be difficulty in turning, but on such streets as Broad and Market St., Philadelphia, and Broadway and Fifth Ave., New York, etc., it could be put into practical operation.

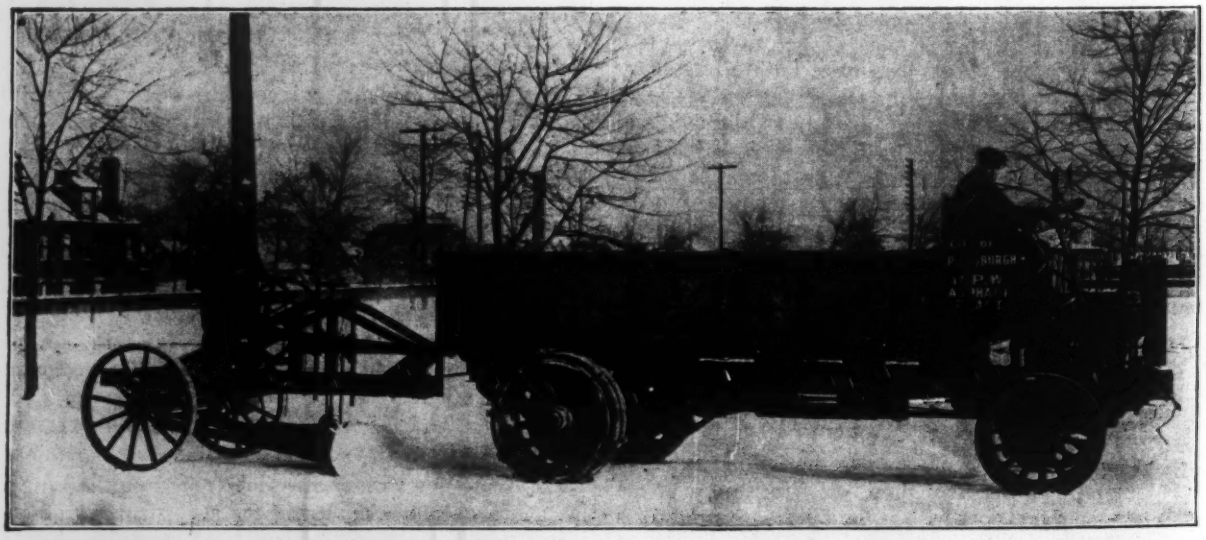
In Philadelphia we are having the regular plow attachment* put on some motor trucks. We also intend to follow Mr. O'Toole's example in attaching some of these road scrapers to the motor trucks, and I have no doubt others would also feel as I do and like to profit by his experience. It is for this reason that I thought publicity through ENGINEERING NEWS would be appreciated by a number of the other cities interested in snow-removal work.

WM. H. CONNELL,
Chief of the Bureau of Highways.
Philadelphia, Penn., Dec. 22, 1914.

A Formula for Paint for Use with Spraying Machines

Sir—Definite and authentic statements as to paint spraying are so rare that the following letter may be of interest:

*See "Engineering News," Feb. 26, 1914, p. 478, and Dec. 3, 1914, p. 1141.



ROAD SCRAPER SNOW PLOW DRAWN BY A MOTOR TRUCK; PITTSBURGH DEPARTMENT OF WORKS

Regarding paint-spraying machines as used by this company, I beg to advise that we have two De Vilbiss Aerons, type "D-15," No. 588, and type "D" with type "A" nozzle, No. 63[illegible] manufactured and sold by the De Vilbiss Manufacturing Co., Toledo, Ohio.

To give you some idea as to the amount of turpentine used in our mixtures, we give you below the first and second coats as applied to our car underframes:

First Coat, Red Lead—	Second Coat, Dark Mineral—
30 lb. red lead.	4 lb. dark mineral.
1½ gal. linseed oil.	¼ gal. oil black.
1⅛ gal. turpentine.	⅝ gal. linseed oil (boiled).
⅛ gal. japan.	¼ gal. turpentine.
3 gal.	¼ gal. japan.
	1½ gal.

Yours very truly,

THE MILWAUKEE ELECTRIC RAILWAY & LIGHT CO.
By H. A. Mullett, Superintendent, Rolling Stock.
Milwaukee, Wis., Nov. 25, 1914.

What the "Dark Mineral" in the second coat may be, I am not informed; obviously a paste paint. The 30 lb. of red lead in the first coat is not dry red lead, but paste red lead containing about 6½% of oil. Translated into ordinary paint language, this first-coat formula becomes 20 lb. dry red lead to one gallon of oil (which would make $1^2/_7$ gal. of a rather thin red-lead paint), thinned with ⅝ gal. of turpentine and 1½ pints of japan dryer, or practically a gallon of volatile thinner to each gallon of oil.

It must be remembered that as applied to metal, all this volatile thinner is merely a mechanical convenience for getting the paint through the apparatus and forming a suitable coating, and would be varied according to the thickness of paint film required. The amount of dryer used would be regarded as excessive except where very quick drying is compulsory. Japan dryer is nearly all volatile matter; and for the turpentine probably a mineral turpentine substitute would be about as good as the real thing. Ordinary dry red lead does not work in these machines, as it settles, hardens and clogs; but the "Dutch Boy" brand of red lead is pure red lead of 98% quality, and remains in suspension, even in so thin a liquid as is here used.

Dipping paints may be made on the same principle, only not so thin. If linseed oil alone were used to give the necessary fluidity, the resulting film would not contain sufficient pigment; hence the need of using a volatile thinner.

A. H. SABIN.

111 Broadway, New York City, Dec. 8, 1914.

NOTES AND QUERIES

"Tamping Track with Air Power"—In the article on track tamping in our issue of Dec. 17, p. 1219, the track-settlement figures tabulated should be in feet instead of inches, as given.

A Happy New Year for the Engineer

Cartoons of the civil engineer, drawn usually by members of his profession, are apt to come to the editor's desk at this season, but the cartoon which we reproduce herewith is from a daily newspaper and may be taken to indicate that some day the civil engineer may come into his own in the way of public appreciation of his work and his achievements. The debonair young man of the picture with his head in the clouds and his hands, or rather his fingers, holding some rather strange-looking instruments, seems entirely capable of undertaking any such little job as the long-span arch at his feet.

This drawing is from the *Spokesman-Review*, of Spokane, Wash., and symbolizes the relation of the engineer to the track elevation of the Northern Pacific Ry. through that city. The work will be about two miles in length, with 12 to 15 tracks at different points, and will be carried on without interrupting traffic. As the caption of the cut remarks: "Lifting two miles of track with their trains is all there is to do."

Some critics of the engineer, critico-engineers themselves, claim that the engineer is too retiring and unassertive for his own good, and probably we shall not unduly inflate his sense of importance and responsibility if we quote the following paragraph of tribute from a "newspaper man":

> The civil engineer who has a part in big construction work and the supervising mechanics who put it in place are the kind of men who keep personal accounts with themselves, accounts they have to square with themselves in the event of failure, no matter how slight degree. It is the most inexorable system of accounting yet devised and it rules the box-car office out on the work as relentlessly as it does the central headquarters, with skylights over the drafting rooms and thick rugs on the office floors.
>
> You get this knowledge of them, not by talking to them, because they don't talk, or if they do, in terse terms only, that would compress the project of shifting the world's orbit into a dozen words. They have the work on hand to do, not to orate over. Days freighted with too much time are rare visitations with them. As matters of routine they have bigger things to do than the jobs of the demigods we know of from epics that have outlasted the wear and tear of centuries. And if you admiringly tacked any of those ancient titles of renown onto one of them he might take a few seconds off and beat you up for it. Which is all there is any necessity for saying here of the man with the transit and knowledge how to do his work.

Lifting two miles of track with their trains is all there is to do.

Legislation Affecting New York City which will be asked of the state legislature this year in behalf of the city government includes authority to build a railway from the Brooklyn Bridge to the Bush Terminal, to be operated jointly by the railroads directly interested; authority to provide a plant for garbage disposal and to maintain municipal markets; and power to exercise excess condemnation, or to take land in excess of what is needed specifically for public improvements.

A Combination Concrete Road and Flood Channel, Los Angeles County, Calif.*

By Ralph Bennett†

In the various semi-arid countries much of the rainfall is in the form of torrential storms. Streams, ordinarily dry water courses, during these storms carry a run-off, in sec.-ft. per square mile, which may even exceed the maximum rate attained in less arid districts.

But few such streams have attained a constant grade line. Their period of flow is too short for them to wear their channels down to a stable slope. They alter their channels from season to season and even from storm to storm. These streams carry much eroded material and are constantly raising the lower portions of their channels, or are eroding new gorges in the soft materials deposited at some previous time.

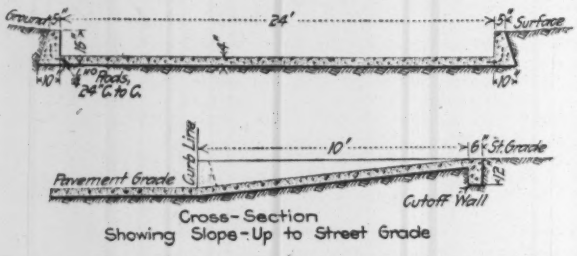


Fig. 1. Cross-Section of Completed Concrete Road and Storm-Water Drain

In bringing valuable land into cultivation for citrus or similar intensive crops, the property must be protected from all possibility of storm-water damage due to such streams.

Whittier Development—Near Whittier, Calif., the Whittier Extension Co. recently completed part of the development work on a property of which the relatively level portions were crossed by a series of shallow barrancas running out from the edge of the hills. These were scattered over the entire piece and did not join in any definite channel in their course across the property.

In order to control the storm flow down these otherwise dry channels, an intercepting ditch was dug paralleling a road on a gently falling grade. The slope of this channel was so slight that it needed no lining, although the entrance of every watercourse was protected by a concrete sill and apron. This ditch delivered the flow of the minor streams into the channel of the largest one. This channel had a slope of from 7% to 2%, and was almost entirely lost in its lower reaches. The addition of the water from the other drains, however, made it certain that the main channel would not only continue to increase in extent, but that the erosion would be serious.

Two types of paved channel were feasible: First, the ordinary concrete-lined ditch; but such channels are a constant inconvenience in the working of adjacent lands and in the maintenance of roads; they require frequent bridges and are liable to be clogged by débris catching against the bridges at the very time when the channel should be clear. Second, a channel extremely wide and very shallow, and with a nearly flat bottom, to be used also as a paved road. This practice of using center gutter roads is unusual in the English-speaking countries, but is almost the standard practice among the Latin races.

During severe storms but little travel moves on an ordinary road, and the flooding of even well laid out modern streets during severe storms is to be expected. Many of the older Southern cities once provided stepping stones on which foot travelers could cross the streets without wetting their feet.

Fig. 2. Construction Work on Combination Concrete Road and Drain, California

Figs. 1 and 2 explain the construction of the combined drain and road as carried out. The first section of the road has been in use for over a year without damage, although it went through one of the severest winters southern California has ever experienced.

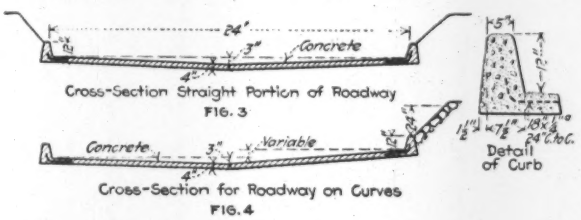
During the storms of the season over 1200 tons of rock, gravel and sand entered the paved road at its upper end, from an unpaved stretch, and passed along the en-

*Noted on p. 750 of "Engineering News" of Sept. 24, 1914.
†1319 Washington Building, Los Angeles, Calif.

tire length of the pavement without damaging it. The 4-in. base has developed only the usual shrinkage cracks. In a few places the surface oil was rather poorly applied and a little wear has occurred at these places. The flat bottom shown in the cross-section, Fig. 1, is a disadvantage as small streams of water flow in an irregular course and leave the entire width of road in a dirty and unsightly condition.

During the present season the road is to be extended on a steeper grade and with a considerable amount of curvature. On the tangent portions of the work the cross-section will be that shown in Fig. 3. The roadway is sloped to a center gutter and the curbs are of a neater and stronger shape than those of the old road, illustrated in Fig. 1.

HYDRAULIC FEATURES—The drainage area is about 400 acres, mostly broken hill land with very steep slopes. The farthest point on the drainage is about 6000 ft. from the head of the paved road. If the gathering period for the



FIGS. 3 AND 4. CROSS-SECTIONS OF PROPOSED NEW CONCRETE ROAD AND STORM-WATER DRAIN

area be assumed as 10 min., which corresponds to the extremely high gathering velocity of 10 ft. per sec., the maximum corresponding rainfall rate will be 2 in. per hr. As both these assumptions are extreme, the flood-flow rate of 480 sec.-ft. given by the rational formula will be so much in excess of ordinary conditions, that it need be provided for only as a brief crest. On a 3% slope the water velocity in the road will approximate 20 ft. per sec., and it will be necessary to bank the curves to keep the main stream in the channel.

The equation for the amount of superlevation required to keep a moving body central on a curved track is:

$$\frac{ab\ (base) \times v^2\ (velocity\ in\ ft.\ per\ sec.)}{32.16 \times R\ (radius\ of\ curve\ in\ ft.)} = e\ (superelevation\ in\ ft.)$$

This assumes that the resulting water surface will be a straight line perpendicular to the resultant of the two forces of gravity and velocity. The result so obtained is sufficiently close for use in channels of this type.

The height of wall required on some sharp curves will be considerable. In this case concrete will be only carried up part way and the remainder of the bank will be protected by hand laid dry rubble. This construction is shown in Fig. 4.

To prevent heavy material being again brought on the road, the upper end will take water over a low weir from a small settling basin.

CONCLUSIONS—While this class of construction offers many striking economies in cost, it has one very serious disadvantage: the road so used must not be the only possible means of access to any important locality, for there will be times, of course, when the road cannot be traveled at all.

Another Water-Supply Project for Ottawa

BY J. A. MACDONALD*

The latest water-supply project for Ottawa, Ont., one conceived primarily in the interests of fire protection, and with existing financial conditions in mind, would retain the unfiltered Ottawa River as the source of supply, locate a high-pressure pumping station on Lemieux Island, substitute two force mains on a bridge for the present submerged pipe beneath the polluted Nepean Bay, and make no immediate provision for filtration.

The new project was presented recently by a special committee of the Ottawa Board of Trade, appointed in November, 1914, because of an increase in fire-insurance rates totaling $120,000 a year which followed fire-protection tests made by the Canadian Underwriters' Association. J. B. McRae, a hydraulic engineer of Ottawa, was a member of this committee. With him in the engineering investigations made were William Kennedy, Jr., and W. S. Lea, of Montreal.

The committee concluded that "on account of the present financial situation, "it would be impracticable" for the city to proceed with any great expenditure," such as would be required for either the Thirty-one Mile Lake project of Alex Binnie and Dr. A. C. Houston, or the earlier McGregor Lake project of Allen Hazen.† It therefore proposed a plan "to meet present exigencies," good for 15 or 20 years, and advised that the two gravity projects be given further study.

This plan provides for retaining the present point of intake just off Lemieux Island "which has never failed due to ice troubles"; for an electrically driven high-pressure pumping station on the island, in place of the existing Queen St. station on the river bank; and for two force mains on a bridge from the island to the shore.

The estimated cost of the new project, including three 20,000,000-gal. pumps, driven by current from the Chaudiere Falls power plant, is $425,000; but from this $65,700 is deducted for savings in reinforcements to the distribution system recommended a few months ago by R. S. and W. S. Lea, of Montreal. It is stated that the scheme would double the present available supply, besides providing a reserve pumping unit.

In case the Ontario Board of Health should refuse to approve this project, with chlorination as the only safeguard to the quality of the supply, "there is sufficient land on Lemieux Island to accommodate a filter plant" of ample size to serve the city for years to come.‡

The recommendations of this committee have been practically indorsed but not officially adopted by the city council. They seem likely, with possible slight changes, to settle the Ottawa water imbroglio, notwithstanding the fact that some of the candidates at the coming municipal election are making the Thirty-one Mile Lake scheme the chief plank in their platform.

*Topographical Survey, Ottawa, Ont.

†See "Engineering News," Apr. 9, 1914, for a review of the various Ottawa water-supply projects up to that time.

‡It should be noted, however, that the Ontario Board of Health recently disapproved the latest Hazen plans for mechanical filtration of the Ottawa River Supply, with an intake at a different and perhaps more acceptable point (See "Engineering News," Dec. 10, 1914). This veto, under recent legislation, makes it imperative for the city to introduce the Thirty-one Mile Lake supply, willy nilly, but the legislation has not yet stood the test of the courts.—Editor.

News of the Engineering World

A New Delaware River Bridge

By a recent act of the New Jersey Legislature a commission has been created to select a location and settle upon a design for a new Delaware River Bridge between Burlington, N. J., and Bristol, Penn. The bridge is estimated to cost $300,000, and $15,000 has been appropriated for the preliminary work. The bridge, to be known as the John Woolman Bridge, after the colonial author and divine, will be highly ornamental, if the tentative sketch by its architect, J. Fletcher Street, of Philadelphia, is followed.

A New Terminal Railway

The Lake Erie & Eastern R.R. will start operating about Jan. 15, 1915. This line, belonging to the Pittsburgh & Lake Erie R.R., is a new double-track location through Youngstown, Ohio, about 6 mi. in length. It has no grade-crossings, and is largely of costly viaduct and embankment construction. While built so as to give a new track connection to the north out of Youngstown, it extends now only to the north city line, and will be operated as the freight terminal line of the P. & L. E. It passes alongside all the steel mills, from the Youngstown Sheet & Tube mill at Struthers to the Brier Hill Steel works at the north end of the city.

A Federal Daily Paper

The first issue of the *Daily Commerce Report*, published by the Department of Commerce, appeared on Jan. 2. Its object is to promote the foreign commerce of the United States. It will contain commercial cablegrams received from attaches at embassies abroad and from consuls throughout the world, and abstracts of findings by departmental investigators.

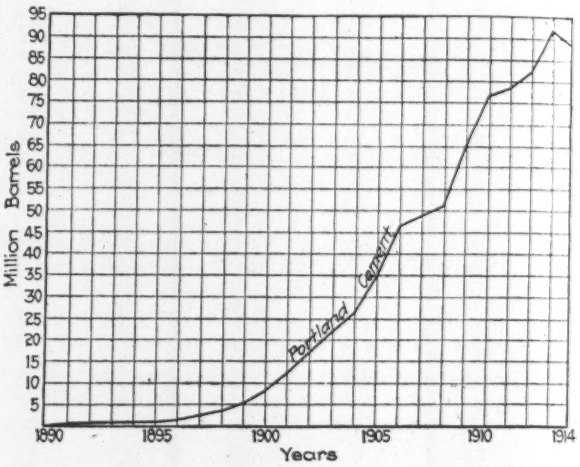
The plan for a commercial daily was worked out by Dr. E. E. Pratt, Chief of the Bureau of Foreign and Domestic Commerce. The paper will replace the *Daily Consular Report*.

Track Elevation at Spokane, Wash.

The Northern Pacific Ry. is about to elevate its tracks through Spokane, Wash., for a distance of two miles. The tracks will be raised 12 to 16 ft., and carried on a solid fill between concrete retaining walls with about 20 bridges over the streets. The passenger station is involved in the change. There are 12 to 15 tracks at some parts of the line and the width of the roadbed will be from 85 to 225 ft. The work will be done without interrupting traffic, which amounts to about 40 regular trains daily. The plan is to build the north wall and then erect a trestle along the north side from which a fill will be made wide enough for two main tracks. Traffic will then be diverted to these tracks, and the filling continued to the south wall. W. L. Darling is Chief Engineer.

Reduced Cement Production in 1914

For the first time since the beginning of industry in the early nineties, the annual production of portland cement is in 1914 less than for the previous year. According to a preliminary estimate by Ernest F. Burchard, of the U. S. Geological Survey, the quantity of portland cement manufactured in the United States in 1914 was approximately 88,514,000 bbl., compared with 92,097,131 bbl. in 1913, a decrease of about 3,583,000 bbl. or nearly 4%. The estimated shipments of portland



PORTLAND-CEMENT PRODUCTION, UNITED STATES 1890-1914

cement during 1914 were 86,715,000 bbl., compared with 88,689,377 bbl. in 1913, a decrease of about 1,975,000 bbl., or 2.2%. On account of the surplus of production over shipments, stocks of cement at the mills apparently increased more than 14%, or from 11,220,328 bbl. in 1913 to 12,818,000 bbl. at the close of 1914.

The Lehigh district of eastern Pennsylvania and western New Jersey showed a decrease of more than 9% in both production and shipments of portland cement. The Illinois and northwestern Indiana district showed a slight decrease, and the Pacific coast district (California and Washington) showed a decrease of about 12%. Important increases in production and shipments were shown by New York State, the Iowa-Missouri district, the Mary- Mountain district.

The annual production of portland cement in the United States from 1890 to 1914 is graphically shown in the accompanying diagram.

Good-Roads Agitation in Pennsylvania

A new constitutional amendment authorizing a $50,000,000 bond issue for the abolition of toll roads and for completion of the state highway system will be intro-

duced at the next session of the legislature, according to the Philadelphia *Public Ledger*. It is stated that

the amendment will be framed on entirely different lines from the one defeated at the polls in 1913. It will be drafted with a view to entirely eliminating the opposition that was advanced against the 1913 bond amendment. The plan provides for an equitable distribution of the money on the basis of the state highways in each county, of county and township roads in each county and of population, omitting cities of the first and second class. The measure will also provide a maximum limit of the bonds which any session of the legislature can issue [$6,000,000 per annum proposed].

A second scheme to raise between $6,000,000 and $7,000,000 a year for highway work is being advocated by the Pennsylvania Motor Federation. This plan provides for raising the entire sum by increased taxation. At the same time an organized attack on the toll-road system is being made by the associated automobile clubs. Jan. 13 has been set for a meeting of automobile owners at Lancaster to prepare a petition to the Public Service Commission asking reduction in toll charges. There are 108 corporations in Pennsylvania still operating toll roads.

Chicago Elevated Railway Valuation

A valuation of the Chicago Elevated Railways, covering their tangible property only, has been made by Montague Ferry, the city's Commissioner of Public Utilities. The total is $52,284,955, which is $1,263,470 lower than that made three years ago by the city's Subway and Harbor Commission, and nearly $41,000,000 lower than that made a little earlier by Prof. Geo. F. Swain, on behalf of the railway companies. The main difference is in the value of real estate, which is taken at about $18,700,000 by the Public Service Bureau, $16,500,000 by the Subway and Harbor Commission, and $46,780,000 by Prof. Swain.

Wireless Telegraph Service of the Lackawanna R.R.

Wireless telegraph stations have been installed by the Delaware, Lackawanna & Western R.R. at Hoboken, N. J., Scranton, Penn., Binghamton and Buffalo, N. Y., and upon the "Lackawanna Limited," running between Hoboken and Buffalo. These installations serve as an auxiliary method of communication, additional to the telegraph and telephone in the event of interruption to wire facilities caused by storm and other damage (such use was noted in ENGINEERING NEWS, Dec. 10, 1914, p. 1190). Actual service trials have proved the practicability and efficiency of the service under emergency conditions between fixed stations and between the moving train and fixed stations. In 1914 there were two storms, during which maintenance of communication between several points on the road was possible only by the wireless equipment. It has been found to meet all uses obtained by the Morse telegraph and to be equally as reliable.

At present the mobile stations are maintained only on the passenger trains noted, but are held to be quite practicable for freight trains at very little expense—provided only one-way service is needed. An installation that would enable freight trains to communicate with a fixed station would be too expensive; acknowledgment of the receipt of communications could be given by a signal, displayed from the train while passing the next station or signal tower. The road's wireless system is under the jurisdiction of L. B. Foley, Superintendent of Telephones, Telegraph and Wireless.

A Sidewalk Bridge Fell, killing three persons and injuring seven, in Kansas City, Mo., on Dec. 28. The bridge was of wood, 100 ft. in length and supported by 4x4's spaced 10 ft. apart, according to reports. The bridge, whose purpose was to protect pedestrians during the construction of the Muehleback Hotel, collapsed when a heavy wagon backed into the supports at one end.

Reading's Camden Station Burned — Fire destroyed the frame station of the Philadelphia & Reading Ry. at Camden, N. J., early on Jan. 3. An adjoining lumber yard and a shipbuilding plant also were burned. Damage to the station is estimated at 200,000. A fire in North Philadelphia, Penn., at 8 a.m. on the same day destroyed a lumber yard which covered about 3½ acres. The yard was well stocked with prepared lumber, chiefly hardwood. Damage to yard and stock is estimated at $700,000.

A Peculiar Transformer Explosion in the Greenwich generating station of the London (England) County Council's tramway system on Dec. 11, 1914, resulted in shutting down the station and completely interrupting traffic on the system. The case of an oil-cooled transformer burst and some temporary heavy wooden staging nearby (erected in the course of station alterations) caught fire and ignited the cables connecting generators to switchboard. It was impossible to extinguish the fire easily and a bad shutdown resulted. No lives were lost and only two generators were damaged. The Council's officials have not said anything about the cause of the disaster but it is believed in some quarters that hydrogen collected in the case and was ignited, for this has happened in other instances where insulating oil of high flash point has been subjected to high electrical stress.

A Blau-Gas Explosion at Hagerstown—What was reported in recent press dispatches as an acetylene-tank explosion in a junk yard at Hagerstown, Md., (see "Engineering News," Dec. 17, 1914) seems to have been a blau-gas and oxygen explosion. We have received the following communication from the secretary of the International Acetylene Association:

Investigation discloses the fact that there was no acetylene tank in use at the junk yard at the time of the explosion. They were using blau gas, purchased from the Chesapeake Blausgas Co., of Baltimore, Md. Blau gas being a liquid gas, it is necessary to have a supplemental receptacle for the expansion of the gas before use, after it leaves the cylinder. A blau gas cylinder had been emptied. The junk people removed the blau-gas cylinder and by mistake attempted to attach an oxygen cylinder. As the fittings didn't match, they went to the extreme of wiring the cylinder onto the connection. The open valve in the oxygen tank allowed the oxygen to mix with the blau gas in the expansion chamber. They ignited the torch, which in a moment blew itself out. They again ignited the torch, and this time a flash-back occurred into the expansion chamber and the oxygen and blau-gas mixture exploded with serious results. These statements clearly show that the human equation entered into this accident to the extent of 100% and that no cylinder of compressed gas of any kind exploded.

A Patent on Deep Foundation Construction, issued to John F. O'Rourke July 16, 1901, No. 678,581, was sustained in a decision by Judge Learned Hand on Dec. 31. The O'Rourke Engineering Construction Co. brought suit against The Foundation Co. for infringement of the above patent. The patent covers a foundation in water-bearing material constructed by sinking separate caissons close to each other, the caissons having so called registering openings in their adjacent walls whereby the spaces between the caissons can be closed and made water-tight after the caissons are sunk. The defendants claimed that the construction described in O'Rourke's patent was anticipated by the method of construction adopted in the foundations of the Postal Telegraph building, on the corner of Broadway and Murray St., New York City. Apparently in this building independent caissons were sunk, but the methods adopted for closing the space between them differed from that set forth in the O'Rourke patent, and the judge held therefore that the latter was not anticipated.

A Snow Removal Drill was held by the New York City Street Cleaning Department on the night of Dec. 30. At 6:45 p.m., without previous warning, Commissioner Fetherston sent out a call for the street-cleaning department's regular employees for emergency snow removal in the Boroughs of Manhattan, the Bronx and Queens. This was done through the Police Department and police patrolmen hunted up the men at their homes. Within three hours 3700 men were at their posts in various parts of the city and went through the motions of removing imaginary snow drifts from the important streets. These men form only a nucleus of a snow-fight-

ing force of 46,000 men provided for under Commissioner Fetherston's plans. An additional reserve force of 35,000 men may be called out in an emergency. The principal purpose of the drill was to teach the regular force of the street-cleaning department how to handle the snow-fighting forces. These regular men are to receive their regular pay of $2.50 per day and emergency men $2.40. If they cope successfully with the storm the regular men will get a bonus, bringing their wages up to $3.75 a day, and the emergency men will get $3.20 a day.

The New York Alien Labor Law was declared unconstitutional by the New York Supreme Court, Appellate Division, First Department, in a decision handed down on Dec. 31. The decision was written by Justice Francis M. Scott, and holds that the act in question violates that part of the 14th Amendment of the Constitution of the United States which says: "No state shall make or enforce any law which shall abridge the privileges and immunities of the citizens of the United States nor deny to any person within its jurisdiction the equal protection of the law." The act in controversy reads:

> In the construction of public works by this state or a municipality, or by persons contracting with the state or such municipality, only citizens of the United States shall be employed and in all cases where laborers are employed on any such public work preference shall be given citizens of the State of New York.

The court quotes various decisions of the Federal court, holding that the above quoted clause of the Federal Constitution extends to aliens the right to engage in contracts, to pursue lawful callings, and to follow ordinary avocations without other impediments than are applied equally to citizens. The court refused to discuss the question whether the act infringed existing treaties between the United States and foreign nations, holding that the decision as to its unconstitutionality was sufficient. An appeal from the decision is to be taken by the Public Service Commission to the highest court in the state, and a decision will be sought from the Court of Appeals as soon as possible. Until such a decision is obtained, it is probable that no further subway contracts will be let.

Notes from Engineering Schools

NEW YORK UNIVERSITY—Study courses for engineers and engineering employees of the City of New York (including the Public Service Commission for the First District, State of New York) are being offered by the extramural division of the university, working in close coöperation with the city administration and having the constant advice and assistance of prominent municipal engineers who have acted as an advisory committee. It is aimed to develop a broadening influence on the city's engineering service. Fundamental preparatory courses have been included and a general survey of different lines of engineering work. Special instructors have been secured, most of whom are or have been in the city's service, and regular class-room instruction will be supplemented where practical with special lectures by prominent men. Each course is supervised by a consulting committee of the advisory committee of municipal engineers, although the administration and instruction is under the direction and control of the university. Classrooms have been provided in the new Municipal Building, except for those subjects which require full blackboard equipment and these are given in the Washington Irving High School. No class will be organized in any subject until at least 15 persons indicate a desire to enter. Each class meets on one evening a week and covers from 20 to 60 hr. Fees vary from $10 to $20, depending upon the length of the course. The courses at present scheduled cover English, mathematics, drawing, surveying, mechanics and graphics, steel and reinforced-concrete design, materials of construction, water-supply, sewerage, highway engineering, waste disposal, waterfront improvements, engineering estimates and contracts, etc.

PERSONALS

Mr. E. T. Reisler, Division Engineer of the Lehigh Valley R.R., has been transferred from Buffalo to the Auburn, N. Y., office of the company.

Prof. John J. Flather, M. Am. Soc. M. E., Head of the Department of Mechanical Engineering, of the College of Engineering, University of Minnesota, is spending a year's leave of absence in Scotland.

Mr. C. E. Bryan, has been appointed Division Engineer of the Ohio River Division of the Baltimore & Ohio R.R., with office at Parkersburg, W. Va. Mr. Bryan was formerly superintendent of the division.

Mr. J. W. Leonard, until recently Assistant to the President of the Canadian Pacific Ry., has left that position to become Superintendent of the Toronto Terminal Co., which has been organized to provide improved terminal facilities for Toronto.

Mr. Chester M. Everett, who for the past eight years has been in the employ of Hazen & Whipple, Consulting Engineers, New York City, was admitted to partnership in the firm on Jan 1. The firm name has been changed to Hazen, Whipple & Fuller.

Mr. Alonzo Rogers Weed, a member of the Massachusetts Gas and Electric Light Commission for eight years past, has been appointed Chairman of the Board by Governor Walsh to succeed the late Forrest E. Barker. Mr. Weed is a lawyer by profession.

Mr. L. P. Rossiter, formerly Assistant Engineer of the Chicago, Rock Island & Pacific Ry. at Manly, Ia., has been appointed Division Engineer of the Lehigh Valley R.R., with office at Buffalo, N. Y., to succeed Mr. E. T. Reisler, transferred, as noted elsewhere.

Messrs. Robert E. Baker and Donald D. Herr, who for a number of years have been associated with Mr. Arthur G. McKee, M. Am. Soc. M. E., have joined Mr. McKee in the incorporation of an engineering and contracting firm, under the name of Arthur G. McKee & Co., Cleveland, Ohio.

Mr. E. Ben Carter, formerly Superintendent of Maintenance-of-Way, has been appointed Chief Engineer of the Florida East Coast Ry., with headquarters at St. Augustine, Fla. Mr. Carter's former position has been abolished, and Mr. C. S. Coe has been appointed Engineer of Maintenance-of-Way.

Mr. Samuel N. Polishook, who for the past 3½ years has been connected with the Bureau of Buildings of Manhattan as an examining engineer, has resigned his position and opened an office as a consulting economy engineer, at 50 Church St., New York City. Mr. Polishook is a graduate of Columbia University.

Mr. Richard H. Aishton, Vice-President of the Chicago & Northwestern Ry., has been appointed by President Wilson to fill the vacancy in the Federal Industrial Relations Commission caused by the appointment of Mr. Frederick A. Delano, M. Am. Soc. C. E., of Chicago, to membership in the Federal Reserve Board.

Mr. Joseph B. Eastman, Secretary of the Public Franchise League, has been appointed by Governor Walsh to fill the vacancy in the Massachusetts Public Service Commission caused by the resignation of Mr. G. W. Anderson. Mr. Eastman graduated from Amherst College in 1904, and has represented street railway unions in arbitration matters.

Messrs. James W. Rollins, Jr., M. Am. Soc. C. E., President of the Holbrook, Cabot and Rollins Corporation, Jasper Whiting, of Boston, special lecturer at M. I. T. and now President of the M. I. T. Alumni Associatfon, and William H. King, Assistant Corporation Counsel of the City of New York, have been nominated for term members of the Corporation of the Massachusetts Institute of Technology.

Mr. Otto Lemberger, formerly a consulting engineer of Chihuahua, Mexico, who will be remembered by readers of "Engineering News" as the author of the article in our issue of Mar. 27, 1913, on stereophotographic surveying, is now a Lieutenant of the Austrian Landsturm. At latest accounts he was in command of a post in the Carpathian Mountains on the Russian-Hungarian frontier. Under date of Nov. 18, he wrote that his command had been in several skirmishes, but had lost more men from sickness and cold than in battle.

Mr. David Watson, son of Mr. John D. Watson, Engineer of the Sewage Works of Birmingham, England, and recently employed to report on sewage disposal at New York and at Chicago, has left his position with Hering & Gregory, Consulting Engineers, New York City, to join the sanitary corps

of the British Army. After eight weeks in training followed by service at the front burying the dead, he returned to England and is now with Sir John Jackson, contractor for the War Department on work for the temporary camps of the Colonial troops at Salisbury Plain, in the south of England.

Dr. Karl Imhoff, well known for the sewage settling tank which bears his name and as Chief Engineer of the Essen Sewerage and Drainage District, Germany, is a Captain of Engineers in the German Army, and has served for a number of months in Belgium and France. A severe attack of dysentery compelled him to spend sometime in a hospital and subsequently to accept the work of training a battalion at Cleve, Germany, but after Christmas he expected to be back at the front with his regiment. One of Dr. Imhoff's associates, Dr. Spillner, formerly in charge of chemical work at the Essen sewage disposal plant, has fallen at the front in battle.

Mr. Charles R. Gow, M. Am. Soc., C. E., Vice-President of the Boston Society of Civil Engineers, has been appointed a member of the Boston Excise Board by Governor Walsh. Mr. Gow is a graduate of the engineering department of Tufts College, 1893, and was assistant engineer and superintendent of construction with the Boston Transit Commission during the construction of the original Boston subway. Later, as contractor, he built sections of the East Boston tunnel and of the Washington St. tunnel. He is now engaged in general contracting for engineering works, and is also a lecturer at the Massachusetts Institute of Technology.

Mr. Adolph F. Meyer, M. Am. Soc. C. E., Associate Professor of Hydraulics in the College of Engineering, University of Minnesota, has been engaged as Consulting Engineer for the International Joint Commission, in connection with investigations made on boundary waters. The investigations have extended over the past two and a half years, and Prof. Meyer has been associated in the work with Mr. Arthur V. White of the Conservation Commission of Canada. The work has involved extensive investigation relating to the regulation of the levels of the Lake of the Woods, and utilization of the waters tributary to that lake. Water power and water supply, navigation, fishing and agriculture are the chief interests concerned. The International Joint Commission is a permanent tribunal with powers of adjudication, created by treaty between Great Britain and the United States. While the work of the Commission thus far has concerned primarily the use of boundary waters along the Canadian frontier, the powers conferred by the treaty are very broad and include, in fact, the decision of practically all matters of dispute between citizens of the United States and Canada referred to the Commission by their respective governments.

OBITUARY

Charles Martin Hall, M. Am. Inst. M. E., the inventor of the electrolytic process for the manufacture of aluminum, and President of the Aluminum Company of America, died Dec. 7 at Daytona, Fla. Mr. Hall was born at Thompson, Ohio, Dec. 6, 1863. He graduated from Oberlin College in 1885. While still a boy, Mr. Hall became interested in the study of chemistry, and after finishing his classical course at Oberlin, became engrossed in the problem of inventing a cheap process of aluminum manufacture, a task on which many of the greatest chemists of the world were then engaged. Mr. Hall succeeded and enlisted the aid of Pittsburgh capitalists in developing his invention. The Pittsburg Reduction Co., was organized with the late Capt. Alfred E. Hunt as President and a little demonstration plant was built at New Kensington, near Pittsburgh. The process was a commercial success from the start and large works at Niagara Falls were soon erected. After sharp litigation with the Cowles electric furnace interests the courts established the priority of Hall's patent in 1893. Mr. Hall was a member of the American Philosophical Society, the Franklin Institute, the American Electrochemical Society and the New York Chamber of Commerce. He was also a Trustee of Oberlin College and had been President of the Niagara Falls Memorial Hospital. Mr. Hall was unmarried and left no near relatives.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 15. Annual meeting at New York City. Secy., J. R. Wemlinger, 11 Broadway, New York City.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 19-21. Convention at Chicago, Ill. Secy., F. J. Angier, Mt. Royal Station, B. & O. R.R., Baltimore, Md.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 20-21. Annual meeting in New York. Secy., Charles Warren Hunt, 220 W. 57th St., New York City.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS.
Jan. 20-22. Annual meeting at New York City. Secy., J. J. Blackmore, 29 W. 39th St., New York City.

INDIANA ENGINEERING SOCIETY.
Jan. 21-23. Annual meeting at Indianapolis. Secy., Charles Brossmann, 1616 Merchants Bank Building, Indianapolis, Ind.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
January 27-29. Annual meeting at Springfield, Ill. Secy., E. E. R. Tratman, 1144 Monadnock Block, Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 9-12. Convention at Chicago, Ill. Secy., E. E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN CONCRETE PIPE ASSOCIATION.
Feb. 15-16. Annual convention at Chicago. Secy., E. S. Hanson, 538 South Clark St., Chicago, Ill.

IOWA ENGINEERING SOCIETY
Feb. 17-19. Annual meeting; at Iowa City. Secy., S. M. Woodward, Iowa City, Iowa.

Society of Automobile Engineers—The annual winter meeting of the Society was held in New York City, Jan. 5-7.

New England Water Works Association—The annual meeting of the Association will be held Jan. 13, at Hotel Brunswick, Boston, Mass. The Secretary is Willard Kent, Civil Engineer, Narragansett Pier, R. I.

Institute of Radio Engineers—At the annual meeting, held on Jan. 6, in New York City, the following papers were presented: "The Design and Construction of Guy-Supported Towers for Radio Telegraphy," by Roy A. Weagant; and "Wood Lattice Masts," by Cyril F. Elwell. The Secretary is Emil J. Simon, 71 Broadway, New York City.

American Society of Agricultural Engineers—The eighth annual meeting was held at the Sherman Hotel, Chicago, on Dec. 28 to 30, 1914. One group of papers dealt with the field for the agricultural engineer, and in the discussion one speaker intimated that there was really no need for such a specialist, or for his special training at an engineering college, as the various lines of work are covered by the civil and mechanical engineer and the architect. To this it was replied that to engage all these for the development of one farm would be far too costly, while few of them have special training in the application of their work to farm problems. On the other hand, the agricultural engineer receives special training in such matters as land drainage, power and machinery for farm use, the design of farm buildings, etc.

The educational side of the question was dealt with at another session, the subject being opened by two papers: "Some Phases of Teaching Agricultural Engineering," by H. C. Ramsover (Ohio State University), and "Instruction to Be Given to Short-Course Students in Agricultural Engineering," by C. I. Gunness (Amherst, Mass.)

One session was devoted to reports of the various committees. The Committee on Standards suggested standard rating and tests for gas engines, standard designs of farm wagons, standard sizes for catalogs and drawings, and the standardizing of sprockets and chains for chain-drive machinery. The Committee on Drainage reported an increasing demand for larger sizes of pipe. The Committee on Motor Contests called attention to the development of small tractors suitable for work on farms of moderate size; such machines are specially favorable for the modern practice of deep plowing. Rules were suggested for competitive contests in plowing and in the assembling and operating of tractors.

A paper on "The Soil Milling Machine," by Max Patitz (Allis-Chalmers Mfg. Co.) described a machine for loosening the soil to a considerable depth. The "Fuel Economy of the Small Farm Type of Gas Engines" was the subject of a paper read by D. P. Davies (J. I. Case Threshing Machine Co.) and E. B. McCormick (U. S. Department of Agriculture), in a paper on "Draft of Farm Wagons," described a series of hauling tests with different wagons traveling over different materials. A paper on "Barn Ventilation," by L. J. Smith (Manitoba Agricultural College), was mainly a comparison of two systems of natural ventilation, but in the discussion it was suggested that this is not sufficient for the proper ventilation of large barns. Two papers dealt with the design and construction of farm houses.

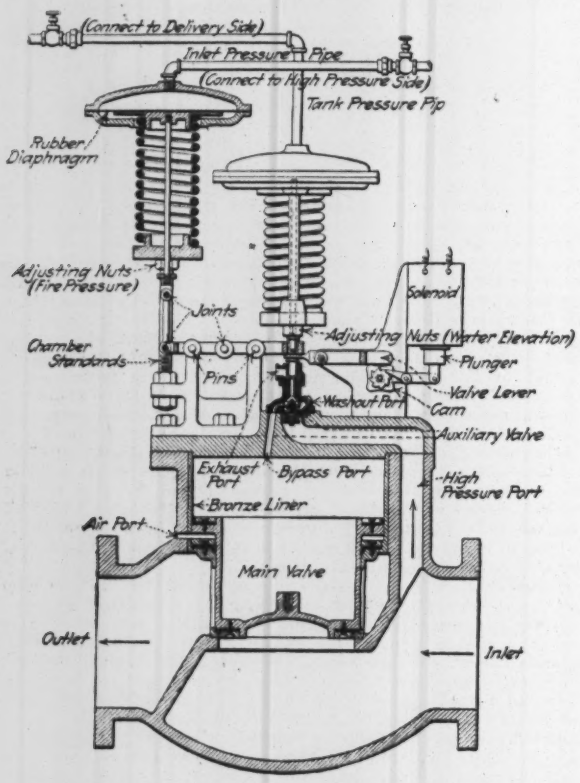
Reference was made to a bill introduced in Congress to establish a Bureau of Farm Power in the U. S. Department of Agriculture. This has not been acted upon, but it seems that its object will be attained by a reorganization of the Department, which is being planned by Secretary Houston. It was suggested that there should be a census of farm power and farm machinery, in view of the great development of the use of power for farm and agricultural work.

The President elected for 1915 is H. H. Musselman, Michigan Agricultural College, East Lansing, Mich. The Secretary is F. M. White, University of Wisconsin, Madison, Wis.

Appliances and Materials

The New Golden-Anderson "Altitude" Valve

A new "altitude" valve for controlling water level in standpipes is shown in the accompanying illustration. In ordinary operation, the main valve is held open by pressure on its under side. When the water level rises to a desired point, pressure in the main control diaphragm pushes the auxiliary valve downward. Then water flows through the high-pressure port to the bypass port and chamber above the main valve. On account of the difference in piston areas above and below, the valve shuts. When the water level falls, the coiled spring moves the auxiliary valve back, the chamber above the main valve is connected to the exhaust port and the valve opens, letting water into the standpipe. Where a considerable increase of pressure is needed, as in case of fire, it is usually desirable to secure the maximum change without



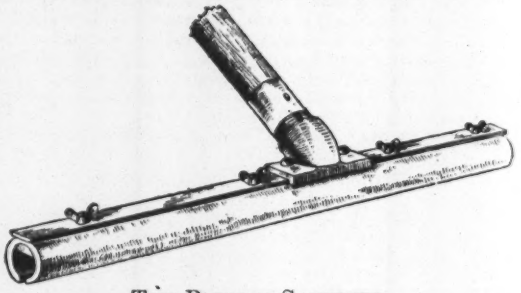
VALVE FOR CONTROLLING WATER LEVEL

waiting for the tank to fill. For such service the excess-pressure control has been added, as shown at the left of the accompanying illustration.

When pressure on the system is caused to rise above a certain point (for which the auxiliary control is adjusted by nuts under the base of the coiled spring), the second diaphragm and connecting-rod move downward, and this movement is transmitted by a connecting-rod and series of levers to the auxiliary valve. For cases where remote control of the excess-pressure feature is desired, an electric attachment has been designed. If current is applied to the solenoid for a moment by closing a circuit (which is immediately opened, however), the plunger is lifted a fixed distance and a pawl on the attached arm moves the cam to a certain position and holds it there. This movement of the cam raises a valve lever and depresses the auxiliary valve, giving action exactly as previously described. The auxiliary valve is thus held open mechanically until it is desired to let water again into the standpipe, when another application of current to the solenoid is made. The second application of current moves the cam so as to drop the valve lever and restore the ordinary control. The valve described is made by the Golden-Anderson Valve Specialty Co., Fulton Building, Pittsburgh, Penn.

A Grout Squeegee

An improved squeegee for grouting brick pavements has been devised by A. J. Parrish, a contractor of Paris, Ill. It is designed to be worked equally well backward or forward. The new squeegee consists merely of a section of rubber hose, split longitudinally and attached to a malleable-iron back-



THE PARRISH SQUEEGEE

plate by bolts and thumb screws as shown in the accompanying sketch. The price is $12 per doz. and the device is sold by the inventor or by the Dunn Wire-Cut-Lug-Brick Co., Conneaut, Ohio.

* * *

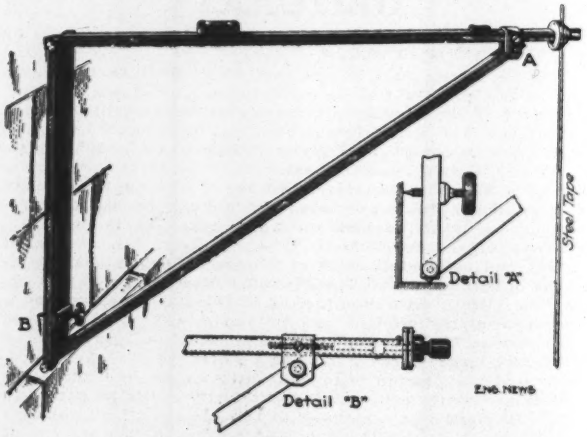
Diesel Engine Te.

Tests of a 225-hp. Diesel engine, built by the Busch-Sulzer Bros. Diesel Engine Co., for the Hugo Ice & Light Co., were recently made by Dr. A. C. Scott, of the Scott Engineering Co., of Dallas, Tex. These tests showed a thermodynamic efficiency of the engine, based upon net useful output, of 29.1% to 31.7%, the loads varying from 80 to 180 kw. Analysis of the exhaust gas showed an entire absence of carbon monoxide or any other combustible gas, proving that complete combustion was attained. The fuel oil used had a heating value of 18,986 B.t.u. per lb., and the consumption varied from 0.442 lb. to 0.461 lb. per b.-hp. net at the loads above named.

* * *

A Level Projector

The novel device shown in the accompanying illustration is designed to be used by engineers and contractors for obtaining the accurate elevation of points on buildings, shafts, projections, etc., which are inaccessible for direct sights with a level rod and instrument. The apparatus consists of a collapsible brass triangular frame, with two spirit levels mounted on the horizontal member. There is a sharp



A LEVEL PROJECTOR

edge at the bottom corner of the triangle and pointed contact points on its vertical side. The lower vertical contact point is a thumb-screw, by means of which the horizontal arm is leveled. On the end of the horizontal arm is a thumb screw for binding the end of a steel tape against an engraved mark, the elevation of which above the contact edge is accurately determined. There is also a second thumb-screw for adjusting the angle of the diagonal arm, that is, leveling the horizontal arm. The suspended tape may be read by a level sight. The apparatus is handy in establishing the elevation of a cornice, window sill, etc., which make admirable benchmarks. The device was invented by Maurice Deutsch, Consulting Engineer, 30 Church St., New York City.